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A SPECTACULAR OIL WELL FIRE, WHICH CAUSED A DAMAGE OF OVER $30,000—[See page 275.]

Health Conditions in the Canal Zone*

The Death Rate is Less Than One Half That of Panama City

By Samuel Horton Brown, M.D.

The entire medical profession is interested in the progress of the sanitary and medical work in Panama because, as in Cuba, it is a part of the opening of a new era, an era in which the medical man is to occupy the position of counsellor, and to rank high in all political and economic problems involving large communities.

It seems strange but none the less true, that a very large proportion of the citizens of the United States are still unaware that the sanitary features of the Isthmus constitute the keynote of the problem of building the Panama canal. This was very forcibly impressed upon me during a recent visit to the Canal Zone (April, 1912), by the remarks of a large body of tourists inspecting the work of the commission with more or less critical eyes. The various details of the engineering were more or less familiar to them, but of the name of the chief sanitary officer, or the methods he employed, they had not the slightest idea, and they deduced from the profusion of mosquito netting that surely there must be mosquitoes thereabouts. As a class, and they represented a fairly typical group of Americans, they appreciated the fact that the isthmus had been a most unhealthy region, but that under the American occupation it had become fairly healthy, as it was to be expected it would be. Just the presence of the Americans alone ought to make it that. Such deplorable indifference to a really great accomplishment is pitiful.

This "fairly healthy" state of affairs is worthy of further investigation. The report of the Department of Sanitation for 1911 aids us materially in such a quest for information. Thus we find in 1911 there were 48,876 employees at work on the canal, of whom 539 died, giving a death rate of 11.02 in a thousand; contrast this if you will with 1904, when the number of workers was 6,213, with eighty-two deaths, a rate of 13.26; and with 1905, when out of 16,512 there were 427 deaths, a rate of 25.86; and again with 1906, when out of 26,547, there were 1,105 deaths, a rate of 41.73. Since May, 1906, yellow fever has been entirely banished. For the month of January, 1912, the death rate was 8.10, and for February 10.57. For March, 1912, it was 8.45. For April, 1912, it was 11.38. For May, 1912, it was 8.01.

The Canal Zone by reason of the centralization of its government is kept in condition much better than the cities of the Republic of Panama, namely, Colon and Panama, although the sanitary department exercises its authority over these two ports. Conditions of life are different there than on the Canal Zone, especially in the city of Panama and it is miraculous that anything is accomplished there.

In looking over the annual average death rate for the entire population of the isthmus, including the civil population of Colon and Panama together with the employees of the canal commission, we find that in 1911 it was 21.46, which contrasts strongly with that of 1905 which was 49.94. For the month of January, 1912, covering the same population it was 17.67; and in February, 1912, it was 16.33. For March, 1912, it was 14.67. For April, 1912, it was 17.21. For May, 1912, it was 19.01. This is more than remarkable when it is taken into consideration that Colon has a population of 19,947, of whom 3,000 are Chinese and about 500 native Panamanians, while the population of the city of Panama is estimated at about 46,555, made up of all nationalities, creeds, and colors.

The death rate for 1911 from disease among the white employees from the United States was 2.82 per mille, while the total death rate from all causes was 5.14 per mille. If the American women and children are included, the death rate of Americans from disease is raised to 4.48 per mille. Including the army and marines in the above the death rate from disease is lowered to 2.36 per mille.

In analyzing the special causes of death among the employees of the canal commission during 1911, they are found to be in the order of their frequency, pneumonia, 94, malaria 47, dysentery 13, typhoid fever 10. Pneumonia seems to have predominated since 1904. Thus in 1905, there were ninety-five fatal cases; in 1906, 413 fatal cases; in 1907, 328 fatal cases; in 1908, ninety-three fatal cases; 1909, seventy fatal cases; 1910, seventy-three fatal cases. At no time during this period did malaria cause more than 233 deaths, nor typhoid fever more than ninety-eight. Dysentery at its worst during this period, never caused more than sixty-nine deaths among the canal employees. Tuberculosis caused fifty-four deaths, nephritis thirty-nine, and abscess of the liver eight deaths. For the month of January, 1912, lobar pneumonia, chronic nephritis, tuberculosis of the lungs, each caused three deaths, while for February, 1912, we find nephritis causing five deaths, lobar pneumonia five deaths, and tuberculosis four deaths. In March, 1912, tuberculosis caused six deaths, chronic nephritis three and lobar pneumonia three. In April, 1912, tuberculosis caused nine deaths, chronic nephritis two deaths, and lobar pneumonia four deaths. In May, 1912, tuberculosis caused four deaths, chronic nephritis five deaths, and lobar pneumonia five deaths.

It will be readily appreciated from these figures that pneumonia, tuberculosis, and nephritis are the most prevalent diseases on the Isthmus since the American occupation. In this respect it bears a close resemblance to the large cities of the United States. The increase in the deaths from pneumonia in 1911 compared with 1910, was due to its almost exclusive occurrence among the colored laborers brought to the zone from the West Indies during the year. This was the case in 1906 when an epidemic of the disease prevailed.

During the entire year of 1911, there were no cases of yellow fever, smallpox, or bubonic plague on the Isthmus, although one patient with bubonic plague of the septichemic variety arrived from Guayaquil, Ecuador, and died in the Ancon Hospital, October 17th, 1911. In January, 1912, the same could be said, although one case of yellow fever was removed from a vessel coming from Guayaquil, Ecuador, and isolated at Culebra Island quarantine station. In February, 1912, no cases of yellow fever, smallpox, or plague originated or were brought to the Isthmus. In March, 1912, a patient with yellow fever was brought from Guayaquil on the steamship "Chile" and died two days later at Culebra Island quarantine station. In April and May, 1912, there were no cases of yellow fever, smallpox, or plague originated on or brought to the Isthmus.

The importance of these cases from Ecuador is readily appreciated when it is recalled that Ecuador furnishes most of the Panama hats and the chocolate beans (cacao) in commerce, and that dirty, unsanitary Guayaquil is the lone seaport of that country.

In segregating according to race, the *annual average* death rate per mille from disease for January, 1912, among employees was, for whites 7.57, and for blacks 3.98, giving a general average for disease of 4.86. These figures should not be confounded with those already given. In January, 1910, the annual average death rate per mille from disease among the whites was 1.95, and blacks 8.91, giving a general average of 7.21; in 1911 from disease among whites 1.89, and blacks 6.23, giving a general average of 5.07. For February, 1912, the death rate for whites was 4.61 and for blacks 7.43, giving a general average for disease of 6.66. In February, 1910, the annual average death rate per mille from disease among the whites was 5.20, and blacks 4.59, giving a general average of 4.73; and in 1911, from disease among whites 5.67, and blacks 6.47, giving a general average of 6.27. The rate for January and February, 1912, has already been given. For March, 1912, the annual average death rate from disease among whites was 2.75, and for blacks 7.90, giving a general average of 6.57. For April, 1912, the annual average death rate from disease among whites was 3.74, and for blacks 10.48, giving a general average of 8.77. For May, 1912, for whites the death rate was 1.95, and for blacks 5.50, giving a general average for disease of 4.61.

External violence causes a great many of the deaths along the canal; thus in 1911 there were 165 deaths from this cause out of 539 deaths from all causes, about 30.3 per cent; in January, 1912, there were fourteen deaths from violence out of a total of thirty-five deaths, or 40 per cent; and in February, 1912, seventeen deaths out of a total of forty-six, 39.1 per cent. In March, 1912, there were eight deaths out of a total of thirty-six, or 22.2 per cent. In April, 1912, there were eleven deaths out of a total of forty-eight of 22.91 per cent. In May, 1912, there were fourteen deaths out of a total of thirty-three or 42.42 per cent. Going over our same figures again we find in January, 1912, the annual average death rate per mille for disease was 4.86, and for external violence 3.24; while in February, 1912, the annual average death rate for disease was 6.66, and for external violence 3.91. In March, 1912, the annual average death rate from disease was 6.57, from external violence 1.88. In April, 1912, from disease the death rate was 8.77, and from external violence 2.61. In May, 1912, from disease it was 4.61, and from external violence 3.40. The death rate from external violence is influenced by direct avoidable causes, and there is no excuse for its periodic increase, although the several other departments of the canal commission call no attention to this when criticising the cost of maintenance of the sanitary department.

Pursuing this feature of the vital statistics a little further we find that among the employees of the Isthmian Canal Commission and Panama Railroad Company (both U. S. possessions), while the actual number of deaths from violence among the colored was greater than the white, the death rate per mille was 4.16 from external violence among the whites, contrasted with 3.11 among the blacks. Despite this, the argument is still used that the West Indian negroes stand the climate and the local diseases better than the whites, whereas it would appear that they stand injuries much better there than elsewhere.

Contrasting the cities of the Panama Republic with the Canal Zone we find other interesting facts. The population of Panama city is 46,555, and the annual average death rate is 31.27; the population of Colon 19,947, and the death rate 26.42; while the Canal Zone has 90,434 persons with an annual average death rate of 15.32. It is expected that the Canal Zone would surpass the cities in this respect, but it is a disappointment to find that Colon is so high in its mortality, especially since its streets are straight and wide and the town itself is comparatively recent.

The great bulk of the deaths on the entire Isthmus were in individuals under one year of age in 1911, something like 1,005 out of the total of 3,368. During January, 1912, the proportion was seventy-eight out of a total of 238, and during February, 1912, it was sixty-five out of a total of 219, in each event heading the list as the most common period for death. In March, 1912, the proportion was forty-nine out of a total of 195, and was the most common period for deaths. In April, 1912, the proportion was sixty-six out of a total of 288. In May, 1912, the proportion was eighty-eight out of a total of 251. Next in frequence, during 1911, was the period between twenty-one and thirty years, for which there were 684 deaths out of a total of 3,368. In January, 1912, the same period was second in frequency, with forty-six deaths out of a total of 238, while in February, 1912, it still held second place with fifty-five deaths out of a total of 219. In March, 1912, this period also held second place with forty-five deaths out of a total of 195. In April and May, 1912, this period held first place. Except in the case of the infants most of these deaths were among males, although the greatest mortality among females occurred at the same period.

The greatest number of deaths occurred among the native Panamanians, something like 1,369 out of a total of 3,368, and only eighteen of these occurred among the employees of the United States Government's industries. The Jamaica negroes rank second in frequency, numbering 699 out of a total of 3,368, of which only three were canal employees. The Barbados negroes rank third, with 405 deaths of whom 140 were canal employees. The natives of Colombia, practically Panamanians who are not loyal to the government, rank fourth, with 144 deaths of which only sixteen are canal employees. Spain is fifth, with 123 deaths of which only sixty are canal employees. Martinique is sixth, with eighty-four deaths, with twenty-eight among canal employees. The United States ranks seventh, with seventy-seven deaths of which only thirty-two were canal employees. If we rate the countries according to their death rate among the canal employees, they fall in the following order: Barbados, Jamaica, Spain, United States, Martinique, Panama, Colombia. This further serves to illustrate that the white man is better off in this country than the colored, if under sanitary conditions.

It is surprising to learn that there were only thirty-seven deaths from alcoholism in 1911 among the employees and civil population of which only four occurred on the Zone. Twenty-six of these deaths occurred in the city of Panama, and five in Ancon Hospital, close by. Among the employees we find ninety-three cases of alcoholism of which ninety-two were discharged, with one fatal. This seems rather meager when the population is 156,936, and Colon and Panama have innumerable grog shops. Either the population stands it well or it is some temperance drink that is sold in these shops. The statistics on the alcoholic imports would be very interesting.

In going over the principal causes of death on the Isthmus, it was remarked that lobar pneumonia, nephritis, tuberculosis, and malaria were the most common and occupied that order in frequency. It was not noted at that time, however, that the colored races were the victims in most of these cases; the most common disease causing death among the whites was malaria.

* *The New York Medical Journal.*

In deaths due to external violence, the colored races predominate again, although in railroad accidents the whites show their greatest mortality, although it is but twenty-three compared with fifty-three among the blacks. It seems scarcely worth while to save these men from the mosquito if they are to be mutilated for the sake of a few extra cars of dirt. Among the employees of the Canal Zone treated in the hospital of the Isthmian Canal Commission, there were 4,288 cases that might be attributed to violence received in the performance of work, of which patients 4,231 were discharged and fifty-seven died.

It is well worth noting in passing that the great bulk of disease occurred in 1911, toward the Panama side of the Isthmus. The death rate of the city has already been shown to be the greatest of any point along the Isthmus, but we also find among the employees a greater amount of illness toward the Pacific end of the canal. This may be because the larger hospital is situated here, but is more likely the cause of the hospital being located here.

The diseases occurring among the employees are very interesting. There were sixty-eight cases of typhoid fever of which ten patients died. This is not necessarily a tropical disease, and it is strange that any should be found here with the great care that is exercised regarding the water supply.

Despite the infinite care that is taken to eradicate the mosquito, malaria still occurs in sufficiently large numbers as to render it a problem. For instance, there were 8,987 cases among the employees, of which number forty-one patients died.

Diseases of the respiratory tract are extremely common and are responsible for a great many deaths, especially among the colored races. Among the employees of the commission there were 313 cases of acute bronchitis and eighty-two cases of chronic bronchitis. There were fifteen cases of broncho-pneumonia with two deaths, and 359 cases of acute lobar pneumonia with eighty-eight deaths. Pleurisy occurred in 118 cases with three deaths. There were fifty-eight cases of other pulmonary affection (tuberculosis excluded) with five deaths.

Bright's disease (chronic nephritis) occurred in 129 cases with twenty-eight deaths, while acute nephritis was observed in twelve cases with four deaths among the employees. There were also 202 cases of tuberculosis with fifty-six deaths in this portion of the canal population.

Regarding insanity, these patients are taken care of in the Ancon Hospital. There were 31 white patients and 267 blacks remaining from 1910, and the new admissions numbered 21 whites and 241 blacks. Of these, 2 whites and 28 blacks died, 13 whites and 146 blacks were discharged, and 7 whites and 72 blacks were transferred. The remainder were still under observation January 1st, 1912.

From the report it would seem that no cases of beriberi were observed among employees, although 83 cases of neuritis were seen in the hospitals. There were, however, 41 deaths from beriberi among the civil population. This is extremely interesting. In 1907, one of the physicians (Ira A. Shimer, assistant surgeon, United States Army; *Journal of the American Medical Association*, March 2d, 1907) noted that this disease was unknown on the Isthmus prior to 1887, which statement is corroborated by the records of the practising physicians and the death records of the municipalities. In 1887, Chinese and African contract laborers were imported, and with them came this disease. Gradually the poorer classes, especially the laborers and colored people, became infected. From the beginning of the American occupation until 1907, the Isthmian Canal Commission had received 112 patients with the disease, of whom 14 died. A local practitioner in Panama alone, up to this period, had treated 450 severe cases. The disease is an important one to the medical men in this country since it not only simulates, but often complicates malaria. In January, 1912, there were three deaths from this cause at Panama among the civil population.

It is the proud boast of the sanitary department of the commission that not a single case of yellow fever has occurred since May, 1906. While this is most creditable to the sanitary department, Col. Gorgas (*Journal of the American Medical Association* for September 7th, 1907) informs us that yellow fever was not always present, at least in a fatal form, on the Isthmus during the French régime. Thus in 1890, 1894, 1895, 1896 and 1898 no deaths were reported; in 1892 and 1893 only one death each year, and in the five consecutive years, 1892 to 1896, only two deaths (the same two, 1892, 1893). Previous to this period, 1881 to 1889, there were a great number of deaths among the employees of the French companies, due to an increase in the imported labor. Whenever a fresh batch of laborers was brought into the country the disease increased until the susceptible ones had succumbed or been rendered immune, when the percentage of the disease would drop to negligible proportions. For instance, in 1884 the French increased their laboring force to 19,000. In 1886 the deaths from this cause alone numbered 308.

The Isthmus of Panama has been a locality noted for the disease that thrived there ever since Balboa discovered the Pacific Ocean, and from the same period the possibility of a canal, natural or artificial, has been the dream of all nations. Consequently all kinds of people, carrying all kinds of disease with them, have journeyed there to acquire the affections indigenous to that locality. But they never went back home with their newly acquired diseases; the Mt. Hope Cemetery bears mute testimony to that fact.

It was not until after the Panama railway was completed that there were any records kept of the mortality of this region. The history of this venture is well worth reading. It was begun in 1850 and finished in 1855, and at times the mortality was so great that it interfered with the construction work. Trains that could have been used in the work had to be used to transport the dead. One construction company, after the work had been given out by contract, imported 1,000 negroes, and within six months, they had succumbed to disease.

On another occasion it was necessary to import 1,000 Chinamen, and these likewise perished within six months. Many of the Chinamen committed suicide.

The French, perhaps, had the greatest difficulties on account of the larger number of unacclimated persons they brought to the Isthmus. During the period, 1881 to 1889, about 5,618 employees died in the hospitals, according to the hospital records. According to Col. Gorgas, the French lost 22,189 laborers by death from 1881 to 1889, giving a death rate of something over 240 per mille in a year. Contrast this with the rate for the calendar year 1911 of 11.02 among 48,876 employees. The average force of the French company during the period 1881 to 1889 was about 10,200 men, and they lost 22,189; the Americans, on the other hand, have had an average force of 33,000 men since 1904, and have lost less than 4,000 men.

While these remarkable results constitute an everlasting monument to the techincal skill and ability of the medical side of the War Department, they also laud the business ability of Col. Gorgas and his staff, as these changes have been brought about, and these good conditions maintained, at an average annual expenditure of $365,000 (according to Col. Gorgas), covering a population of about 150,000. There should be no criticism of this feature of the canal work, although there seems to be a tendency to regard this as extravagant. Comparison with the health budgets of the larger American cities will show it to be in the line of real economy, as the money brings the results for which it was intended.

For the year 1911 (1912 report, p. 31) the net cost of operating the hospitals was $578,164.33, and of the sick camp $22,144.79, making a total of $600,309.12, somewhat higher than the figures given recently by Col. Gorgas in an article (*Journal of the American Medical Association*, March 30th, 1912). Col. Gorgas stated that the expense of sanitation amounted to $365,000 per annum, but did not state whether that included hospital service. Doubtless they are kept as separate expense accounts. However, the higher figures are not too high, since the gross cost per capita in the hospitals was $1.21 per diem, and in the sick camps $0.44 per diem. Some patients paid and some were paid for by the Panama Republic, so that the net cost per capita was $0.97 per diem in the hospitals. It would be very difficult to conduct such a large clinical service (51,679 cases) anywhere at such a moderate cost.

An echo of the large number of saloons in Panama and Colon is doubtless to be found in the statistics, covering the employees sick in their quarters. There were 16,680 days scored up against the whites, compared with 2,384 days against the blacks. The consolidated hospital report showed 18,594 white patients sick, compared with 15,602 colored patients. The consolidated sick camp report showed 6,205 whites compared with 12,091 blacks, while the consolidated dispensary report showed 244,059 white patients compared with 269,960 colored patients. Among the non-employees, 72,672 whites and 56,394 colored patients were seen at the several dispensaries. The days lost in the quarters for illness not sufficient to consult dispensaries or hospitals and be properly classified certainly seem to point to a very obvious cause.

One of the greatest features of Col. Gorgas's work is shown in the fact that the average number of employees constantly sick, per mille, is 45.88 for the white and 17.30 for the colored population.

The surgery performed in the several hospitals is quite extensive, numbering 7,701, and in only seventy-nine instances did the patient fail to recover. These operations ranged from the simplest minor procedure to excision of the tongue, thyroidectomy, and major abdominal operations. In the eye, ear, nose, and throat clinic, 2,407 additional operations were performed without a single death.

From the foregoing statistics it may be readily seen that the health conditions of the Isthmus compare favorably with almost any other industrial section of a like population; indeed it is vastly superior to many. When it is considered that the sanitary department covers so many fields the expense is trivial. No other health department exercises such rigid or conscientious surveillance over the people in its charge. Possibly when the canal is completed and the sanitary department has assumed an automatic character, its several heads could be placed in charge of our larger American cities with the same authority vested in them as on the Canal Zone. Perhaps, we may then persuade our own people that flies and mosquitos are not necessities and that their removal is not an interference with any one's constitutional prerogatives.

A Spectacular Oil Gusher Fire

(*See our frontispiece.*)

Our modern methods of operating industrial enterprises on a gigantic scale brings with it its own penalties. So long as the giant forces which we have pressed into our service remain under our control, all is well. But now and again, though we observe the greatest vigilance, our unwilling servants break the bonds, and then the havoc wrought is in proportion with the magnitude of the useful services rendered by them under normal conditions.

Thus the very while our thoughts are occupied with the preservation of our natural resources, some untoward accident sets fire to a great oil gusher, and a matter of $30,000 goes up in smoke. For this is the figure at which is estimated the loss incidental to the spectacular oil gusher fire depicted upon the front page of this issue. The well is one in the California fields, and it has been estimated that at the time it caught fire the gusher was spouting seven thousand barrels of oil a day. As the burning oil was thrown aloft, it formed a blazing torch three hundred feet high. More than a week elapsed before persistent efforts finally subdued the fire, the steam from a number of boilers being called into requisition for this purpose. Eighty acres of the surrounding land were burnt over, including stored oil, derricks and buildings.

Anti-Typhoid Vaccination

Anti-typhoid vaccination has been undertaken by the War Department with such excellent success that the U. S. Geological Survey, the Land Office and the Reclamation Service are inoculating volunteers in their various corps. Other construction camps than those supervised by the Government might well look into the practicability of vaccinating at least their engineering and directing forces. Outbreaks of typhoid fever in a camp are likely to give it an unsavory reputation, causing the more enlightened and usually more skillful and efficient workman to shun it. Most large camps have a physician in charge whose duties are not so arduous but what he could easily include typhoid vaccination. Typhoid carriers may be the cause of an epidemic, more or less serious, even though the highest degree of sanitary excellence is maintained. At a mountain camp of 200 men, recently visited, the physician's cabin was located not 500 feet from a fly-harboring garbage heap. Moreover, there was typhoid in the camp, probably fly-borne. On some of the larger construction works excellent sanitary regulations are enforced, but engineers on small as well as large contracts should insist that the physicians with whom they deal directly keep abreast of the times in sanitary matters, and enforce adequate sanitary regulations in the camps under their charge. This is of as much importance as the sewing of cuts and the setting of broken bones. The typhoid-vaccine treatment is so simple and the reaction in most cases so much lighter than small-pox vaccination that it is surprising the general public does not know more about it. Three injections are made at intervals of ten days. Of 100 persons in the Geological Survey who were recently vaccinated, less than 10 per cent experienced any discomfort and none had any severe symptoms. If present at all, the reaction is manifested only by headache, malaise or slight fever. In some States various boards of health are furnishing the vaccine free or at a nominal cost. Immunity, according to results obtained by the army physicians, by whom about 130,000 doses have been administered, is obtained for at least 2½ years.—*Engineering Record.*

Eliminating Disturbing Noises From the Telephone

According to the German periodical *Umschau*, a Swedish engineer named Saxenberg has invented an effective device for eliminating, or at any rate greatly diminishing, adventitious noises in telephone conversation. The device consists of a variable water-resistance. One such apparatus is provided near each of the transmitters, and the person speaking can, by adjusting the electrodes in the water resistance, regulate conditions to such effect that secondary noises are reduced to a minimum.

View of the Furnace With Combustion Chamber Above. The Trough for the Separation of Metallic Lead from Slag is Seen in Front of the Furnace.

View Showing the "Beehive," Where the Fume is Purified, and, in the Distance, the "Goose-necks," Large Inverted U-Pipes.

Sublimed White Lead*

Its Manufacture and Properties

By John A. Schaeffer, Picher Lead Company, Joplin, Mo.

The manufacture of sublimed white lead, the commercial name for the basic sulphate of lead, prepared by the sublimation process depends directly upon the oxidation of galena, the sulphide of lead, when subjected to intense heat in an oxidizing atmosphere. The combustion under these conditions proceeds with violence resulting in the formation of a white sublimate, which when purified is known as sublimed white lead.

* Paper read before the Eighth International Congress of Applied Chemistry.

The reaction which occurs in this oxidation of galena may be written as follows:

$$6\ PbS + 11\ O_2 = 2\ Pb_3S_2O_9 + 2\ SO_2.$$

This formula $Pb_3S_2O_9$, or 2 $PbSO_4.PbO$ is analogous to the generally accepted formula for the basic carbonate of lead—$2PbCO_3Pb(OH)_2$. Commercial sublimed white lead, however, contains a higher percentage of lead sulphate than that required for the above theoretical formula. While the formation of the theoretical basic sulphate of lead is entirely feasible, its manufac-

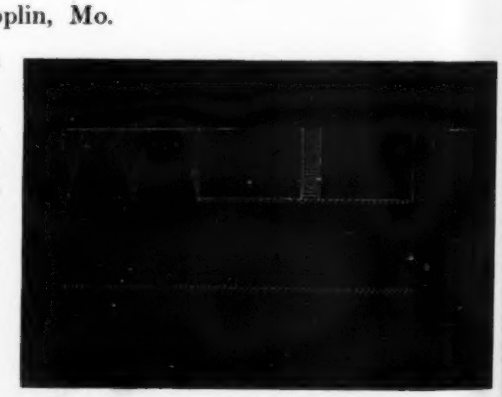


Diagram Showing the Location of the Furnaces in Relation to the Combustion Chamber and "Beehive."

The Hoppers Into Which the Sublimed White Lead Falls from the Bag Room.

Diagram Showing the Arrangement of the Bag Room.

ture has not proven commercially advantageous. The conditions for the oxidation of the sulphide of lead are, consequently, so adjusted that a compound showing about 16 per cent of lead oxide is obtained. The conversion of a small percentage of the lead oxide, present in the theoretical basic sulphate of lead, to lead sulphate undoubtedly results from a reaction between the lead oxide and the sulphur trioxide which forms from the oxidation of a certain amount of sulphur dioxide. A small percentage of zinc oxide is formed at the same time from the sphalerite, the sulphide of zinc, which is present in almost all non-argentiferous lead ores. It is maintained that the presence of about 6 per cent of zinc oxide enhances the value of the pigment.

Coke, of a hard compact variety is used as fuel, while iron, in the metallic form, and limestone serve as fluxing materials, together with the silica present in the ore. Any metallic lead which forms from a reduction of the lead compounds by the coke, at the intense heat continually maintained in the furnace, is separated from the readily fusible slag by a difference in their specific gravities.

Blue Fume, the fume known commercially as sublimed blue lead, is frequently added to the charge. This fume is formed in the smelting of lead ores and is recovered by the bag room process. It is found to contain about 35 per cent of lead oxide and about 50 per cent of lead sulphate. This fume pigment, sublimed blue lead, is rapidly finding extended use as a paint pigment for the protection of iron and steel. Its composition renders it extremely valuable as charge material and being a product of sublimation is extremely reactive when subjected to the conditions found in the oxidizing furnaces.

The method of charging the furnaces varies with atmospheric conditions and the life and temperature of the furnace, charges being formulated to meet these conditions.

By following the charge from the raw materials to the finished products, the general working conditions can be best understood.

The oxidizing furnaces, two being considered a unit, consist of oval iron water-jackets, four feet in height, open at both ends, the upper end being five feet in length and three and one half feet in width.

This water-jacket is securely built in a brick structure, on a solid brick base, and has a small opening in front which serves as a tap hole for the continuous removal of slag and metallic lead and their separation by the difference in their specific gravities. An oxidizing atmosphere is maintained by blowing air through tuyere holes entering near the base of the furnace. The feed door of suitable size and form is placed at one side of the furnaces.

The brick work surrounding the water-jacket or furnace proper is extended upward so as to form a large combustion chamber which is in some cases water-jacketed.

Immediately upon feeding the charge into the furnace, the fire of which is maintained at a point of incandescence, the reactions theretofore described occur with great violence and the volatilized lead passes upward into the combustion chamber.

Suction is maintained by a powerful fan placed between the bag room and the "goose-necks" which draws the condensed fume onward through the cooling system, finally driving it into the bag room where it is deposited.

The cooling system is built so as to produce maximum cooling effect by the introduction of baffles which prevent the easy passage of the fumes into the bag room. After the fume has passed out of the beehive, where it is condensed and purified, it is drawn through the "goose-necks," large inverted U-shaped pipes resting on hoppers, by the large suction fans and thence forced into the bag room.

The bag room is of a special type somewhat similar to those used in the collection of all fumes.

In the sublimed white lead bag room, however, are found three rows of hoppers (see diagram), each hopper carrying 24 bags. The pressure of the fan forces all the gases through the cloth of the bags, while the sublimate is deposited. Occasional shaking throws the fume into the hopper, where it is packed for shipment.

Sublimed white lead as it is removed from the hoppers is white in color. Much fume, however, which is unsatisfactory and not suited for use in the various arts is deposited in the portion of the cooling system preceding the suction fan. This fume is contaminated with a small percentage of coke, ash and other impurities, and being of a higher specific gravity than pure sublimed white lead, is readily deposited before reaching the fan, by a careful adjustment of the suction. The fume becomes darker in color the nearer the approach to the furnace. As a charge material the sublimate is excellent owing to its very finely divided condition.

Sublimed white lead, being a fume product, consists of very fine amorphous particles, in size about one thirty-five thousandth of an inch in diameter. Its specific gravity is found to be 6.2.

In composition it shows approximately 78 per cent of lead sulphate, 16 per cent of lead oxide and 5.5 per cent of zinc oxide. That the lead oxide present is chemically combined as a basic sulphate of lead, the sulphate of lead present in excess of the amount required for the theoretical formula being present as neutral sulphate of lead, is held by practically all authorities. Chevalier claims the formula of $Pb_3S_2O_9$ for the fume resulting from a furnace roasting lead sulphide.

According to Toch,[1] we find, that "A Mixture of precipitated lead sulphate, litharge and zinc white is approximately the proportions found in sublimed lead, when ground in oil and reduced to the proper consistency, dries totally different from sublimed white lead; in fact, sublimed white lead when ground in raw linseed oil takes two days to dry dust free, but the mixture just cited will dry sufficiently hard for repainting in twelve hours, because lead sulphate is a fair dryer and lead oxide a powerful one. The oxy-sulphate having the same composition, behaves totally different from the mixture." A mixture of the neutral lead sulphate with two per cent of sublimed litharge, the finest and palest oxide of lead yet prepared, shows a yellow color not approached by any sublimed white lead yet made.

When sublimed white lead is subjected to the heat of the blow pipe it is only reduced to metallic lead, when intimately mixed with charcoal, with the greatest difficulty. It shows only slight darkening in an atmosphere containing appreciable amounts of hydrogen sulphide gas. When used in colored paints containing chemically reactive tinting materials it exhibits chemical inertness. The tinctorial power and opacity is directly lowered with a decrease in the percentage of lead oxide.

When chalking is noted in paints containing high percentages of sublimed white lead, it is found to differ from that noted in the case of other white lead pigments. According to Holley,[2] we find, "When ordinary white lead begins to chalk vigorously, it will be found that the paint film has lost its elasticity, and has become brittle and friable throughout; also, that the luster of the film under the chalk-like coating has entirely disappeared. A sublimed white lead film, on the other hand, retains much of its original elasticity under the chalk coating, indicating that the disintegration is confined to the surface, and it is possible that the retention of the 'chalk' on the surface gives some protection to the unaffected coat below."

The pigment in common with other white lead compounds, finds its greatest value when compounded with zinc oxide and a small percentage of inert pigment of a crystalline nature, as these pigments tend to overcome those factors which militate against the use of the pigment alone.

Sublimed white lead is a pigment extensively used in the compounding of the finer grades of rubber goods.

The pigment has been found to practically inhibit corrosion on iron and steel even after long exposures, and ranks favorably with all other pigments yet prepared for the elimination of this decay. In consequence, it is rapidly finding its predicted place among paint pigments not only as a protective coating for wood, but as a preservative for iron and steel.

[1] "Chemistry and Technology of Mixed Paints." p. 19.
[2] Zinc and Lead Pigments." Holley, page 115.

The Corliss Engine*

What Is Its Distinctive Feature?

By F. R. Low

I suppose there is hardly an engineer who would balk at the question, "What is a Corliss engine?" and who would not be surprised when he found how difficult it is to tell. Corliss certainly did not invent the four-valve engine. All the earlier engines had separate steam and exhaust valves, and it was only a later stroke of genius which combined the functions of all four in the ingeniously simple D-slide valve. Corliss did not invent the cutoff, as many suppose. Steam was cut off and used expansively in the engines of Watt. He did not originate the idea of regulating the speed of the engine by varying the cutoff instead of the initial pressure. In one of his own patent applications he refers to a description in Tredgold's "Treatise on the Steam Engine," of an engine which had poppet valves operated by a cam under the control of the governor; to the description by the French author Armengaud, in his *Publication Industrielle*, of another engine in which the regulator acted upon a cam which was made to act upon the valve rods so as to close the valves at varying portions of the stroke; and to a description in *The Practical Mechanic and Engineers' Magazine*, a Scotch publication, in 1846 of an engine with a riding cutoff under the control of the governor. These were all prior to Corliss's first patent, which was not issued until 1849.

* Reproduced from *Power*.

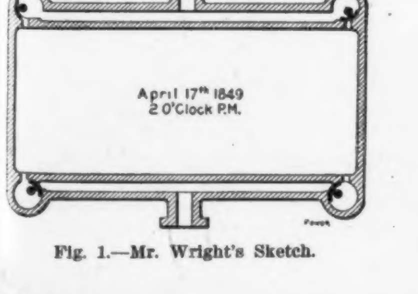


Fig. 1.—Mr. Wright's Sketch.

Fig. 2.—Method of Operating Valve.

Zachariah Allen, an engineer of Providence, patented, in 1834, an arrangement whereby the governor valve, instead of being opened more or less and throttling the pressure according to the load, was opened fully at the commencement of the stroke by a lever resting on a cam on the main shaft. The cam was wedge-shaped, and when the bearing end of the lever rested on its narrow end the valve was held open but a short fraction of the stroke. When it was changed to the wide end of the cam the valve was held open for the greater part of the stroke, and its position upon the cam was controlled by the governor. An engine of this type was put into practical operation at Providence, in 1834.

In 1842, F. E. Sickels patented the Sickels valve, so well known in marine practice. Here the *main* valve is made to do cutting off by means of a trip-motion, the shock of the closing poppet valve being taken up by means of "cushions of yielding water," whence comes the term "dashpot," still applied to the modern substitute, which has nothing to suggest a dash about it.

Sickels was a marine engineer, and marine engines use no governor. He made his detachable or trip cutoff adjustable by hand, so that the speed could be controlled by shortening the cutoff instead of by throttling, but unfortunately for himself, though luckily for Corliss, he did not suggest in his patent specifications that this might be done automatically by the governor.

Under date of February 3rd, 1870, Zachariah Allen

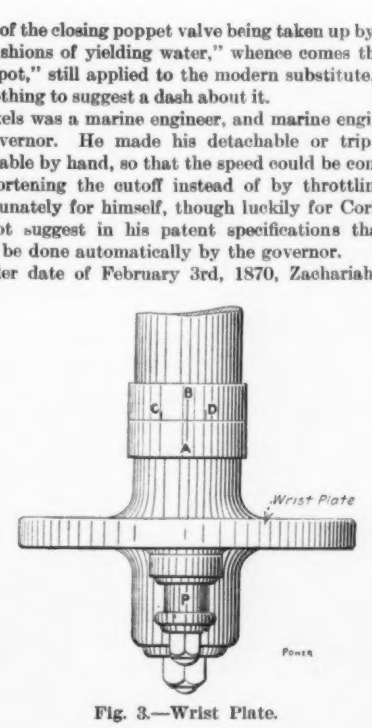


Fig. 3.—Wrist Plate.

wrote to Mr. Corliss a remonstrance against his acceptance of the Rumford medal which had been awarded to him by the American Academy of Arts and Sciences for inventions that originated "the abolition of the throttle valve of the steam engine and for placing the induction

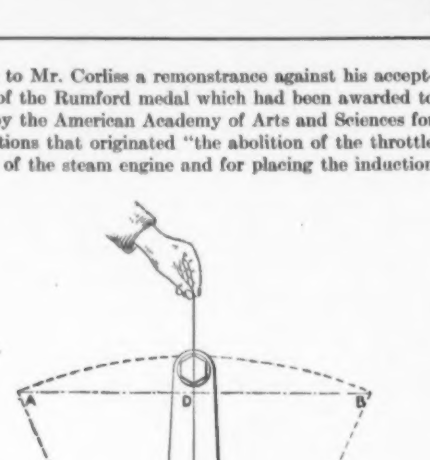


Fig. 4.—Equalizing Travel of Rocker Arm.

valves under the control of the governor." In the course of his letter he describes a combination of his own and Sickels' invention as follows:

"You have frequently seen the large steam engine in the print works constructed by my brother, Philip Allen, near your office in Providence, and now under my charge, and are aware that it has been operated by the use of a ball regulator applied to produce a variable and detachable cutoff movement, as described in my patent and in the improvements patented by Mr. Sickels independently of the use of a throttle valve, and of any of your claims for steam-engine patents.

"This steam engine has been in operation during the whole term of fourteen years of your outstanding patent claims, and is now operating excellently well, with an economy of coal, and a perfection of effective power, as indicated by diagrams, unsurpassed, as I believe, by any engine of your construction."

In the course of the same letter he says further:

"While you have originated a rotary valve, with new and peculiar devices for producing with that valve the same results which had been previously effected by the above described inventions of your predecessors, you must certainly feel that you are not the first person who promulgated or accomplished these inventions, nor the first to reduce them to practical use."

Ah! the Corliss valve, known as such all over the world. Now we have got to something essentially Corliss. But his claim even to this is not undisputed. In the early days of my connection with *Power* I called upon William Wright, at Newburg, one day when the old gentleman was in a reminiscent mood. We talked of Corliss and of the time when Wright was superintendent of his shop, and the old man went to the safe, rummaged through some drawers and produced from between the leaves of an old notebook a time-worn sketch, yellow with age, and proceeded to tell me this story of the inception of the Corliss valve.

A few engines had been built in which the releasing gear invented by Mr. Corliss had been applied to different forms of slide valve with more or less satisfaction, mostly less, so far as the practical working of the valve was concerned. Meanwhile the efforts of the inventor were bent in the direction of a valve better adapted to the requirements of his cutoff, which had demonstrated its superiority as a means of regulation.

At this time an order had been taken for the Eddy Street Foundry, of which the father of William A. Harris, of the engine company of the same name, was superintendent. The frame and connections of the beam engine had been made, but the cylinder had been allowed to wait, pending the evolution of an improved valve. Mr. Harris became urgent in his demands for delivery, and on April 17th, 1849, Mr. Wright approached Mr. Corliss with the question of the delayed cylinder. In the course of the conversation which followed Mr. Wright took up a piece of paper and made the sketch shown in Fig. 1. The suggestion was greeted by Mr. Corliss with the statement that if he could not have something better than that he would not have anything. Nothing better seems to have offered, however, for thousands of engines have been built in this way, and the appliance shown is universally known as the Corliss valve.

This sketch has recently been presented to me, along with other mementoes of her father, by Mr. Wright's daughter, and I am thus able to show the original, creased and worn, held together with tracing cloth, and bearing upon its back, almost undecipherable, the date of its alleged production. I do not know that any patent was ever taken out upon this valve. It does not seem to have figured in the long and bitter litigation in which the Corliss patents were involved and it was only after the death of Mr. Corliss that this sketch was brought to light, notwithstanding Mr. Wright was an opponent to Corliss in some of the patent suits.

It is probable, if the authenticity of the sketch is admitted, that Corliss found possibilities in it upon examination that failed to impress him at first sight, and

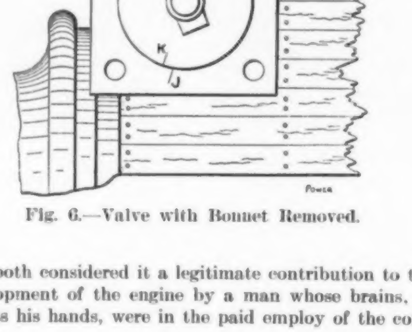


Fig. 6.—Valve with Bonnet Removed.

that both considered it a legitimate contribution to the development of the engine by a man whose brains, as well as his hands, were in the paid employ of the company.

What, then, is a Corliss engine, and why does George H. Corliss justly stand, in the popular estimation, by the side of James Watt as a factor in bringing the engine to its present state of efficiency?

George H. Corliss was born on June 2nd, 1817, at Easton, N. Y. He acquired an academical education at Castleton, Vt., and in 1844, at the age of 27, he went to Providence and associated himself with John Barlow and Edwin J. Nightingale, under the name of Corliss, Nightingale & Co., for the manufacture of steam engines.

Corliss was a man who went to the very bottom of things. He had not been in the engine business long before he saw the weaknesses of the machine as then built, and in 1848 he applied for the first patent for his improvements. This patent was issued on March 10th, 1849, and the first thing it goes into is the bracing of the frames of beam engines.

"The third part of my invention," he says in his application, "relates to the method of regulating the cutoff of the steam in the main slide valves, and consists in effecting this by means of the governor, which operates cams, so that when the velocity of the engine is too great, these cams shall be moved by the centrifugal action of the regulator, that a cam on the valve rods may sooner come in contact with them to liberate the valves and admit of their being closed by the force of springs or weights, and thus cut off the steam in proportion to the velocity of the engine."

His claim relating to this feature is as follows:

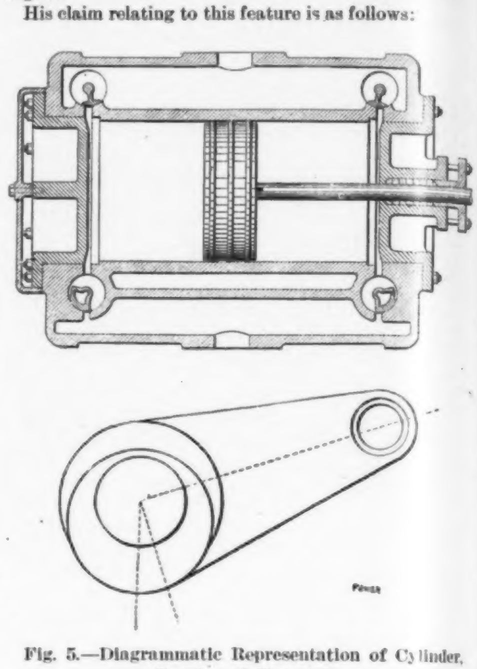


Fig. 5.—Diagrammatic Representation of Cylinder, Crank and Eccentric.

"I claim the method of regulating the motion of steam engines by means of the centrifugal regulator, by combining the said regulator with the catches that *liberate* the steam valves by means of movable cams or stops, substantially as described."

How could Corliss get this claim allowed with Allen's patent and the existing descriptions of other automatic cutoffs before the examiners? Because Corliss's was a *liberating* gear. It dropped the valve when the governor said so, and let it get closed as quickly as weights or springs could close it. In Allen's and the other cases, cams opened the valves, and without releasing them placed them back in the closed position. In an application for a reissue of one of his patents, in 1859, he said:

"I wish it to be understood that by the term 'liberating valve gear,' as I have used it in this specification, I do not include those previous arrangements for working valves, which consist of cams or various forms to open the valves and then, at certain periods of their rotation, suffer the valves to be closed by the force of weights or springs, but control and graduate the closing movement. Such arrangements of valve gear lack the capacity for varying the periods of closing the valves, combined with the promptness of closing at all speeds of the engine, which characterizes my improved valve gear."

We have, then, as a distinctive feature of the Corliss engine the liberating, or detaching, valve gear under the control of the governor. Sickels had the detaching gear, but he had not specified it as a means of speed control nor combined it with the governor. Allen had the automatic cutoff, but not the detaching mechanism, and yet their combined inventions did not make a Corliss engine.

In the valve gear, the method and mechanism for operating the valves, considered apart from the governing feature and the particular form of the valve, lies the feature of the Corliss engine the originality and ingenuity of which are unchallenged. This invention is described in his first patent application as follows:

"In steam engines operated with slide valves, particularly the large condensing engines used in England,

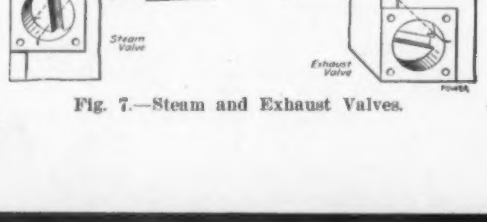


Fig. 7.—Steam and Exhaust Valves.

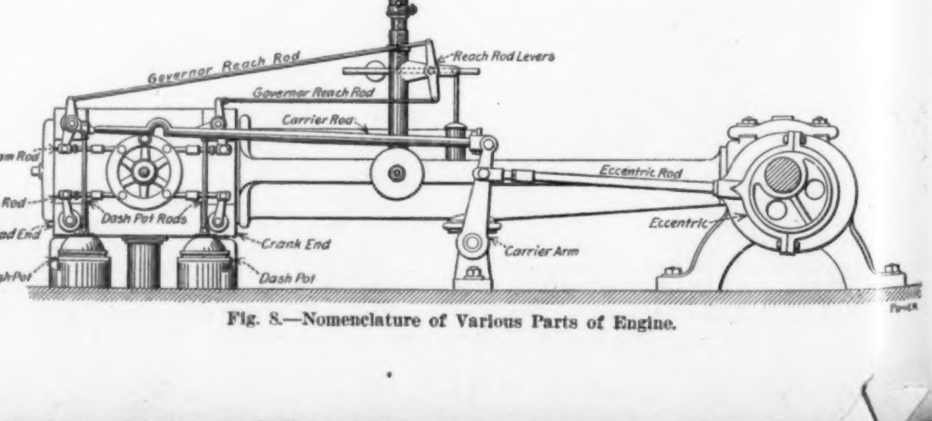


Fig. 8.—Nomenclature of Various Parts of Engine.

the valves are connected together and move together in pairs, one at each end of the cylinder, and therefore move together over the same extent of surface; and as the power required to move them is due to the friction produced by the pressure of the steam on their surface, and their range of motion under this pressure, it follows that the valves, while closed, require the most power, for much of this friction is relieved the moment the valves are partly opened.

"One of the valves must always be closed while the other is being opened or closed; hence the closed valve is moved at an entire sacrifice of power.

"To save this several devices have been resorted to, such as cams, the irregular working of which makes too much noise and renders the whole liable to derangement; but by my invention I am enabled to reduce the motion of the closed valve relatively to that of the other valve, and thus greatly to reduce the amount of power hitherto required for this purpose. This, the second part of my invention, therefore consists in communicating motion to the two valves from one rock shaft, by connecting each valve with a separate arm or crankwrist of the rocker, the two arms making such an angle with each other dependent upon the position of the valves and the rocker, so that the point of connection of the closed valves shall vibrate near the dead point and therefore give but a small amount of motion to that valve, while the other, which is being opened and closed, is moving along that part of its circuit which shall give the greatest longitudinal motion, and therefore giving to that valve the greatest amount of motion."

The meaning of this will be apparent from Fig. 2, where it will be seen that the crank in moving from its present to its dotted position would give a considerable movement to the valve to which it is connected, while the other crank would give little movement to its valve.

It is a singular fact, in view of the widespread impression that Corliss's principal contribution to the engine was the automatic cutoff, that this really distinctive feature of his engine applies with most of its force to the exhaust valves, for the idle steam valve is detached from the operating mechanism, and is not in a position to profit by its advantages. The natural development of the idea, however, was to operate all four valves from a single oscillating member, and the valve gear took the form of the four operating levers attached to the familiar pumpkin-seed-shaped wrist plate, with centers so located that the valves received their quickest movement in opening and closing, and remained practically still when necessary movement had been accomplished.

On all but the smaller engines the motion is transmitted from the eccentric through a rocker arm, and as this motion will be distorted if this arm is allowed to vibrate to unequal distances to either side of its center of suspension, the first operation in setting an engine in which such an arm is used is to equalize its travel. This is most easily done for a horizontal engine by dropping a plumb line through the center of suspension, as in Fig. 4 turning the engine over slowly or rotating the eccentric and adjusting the stub-end E, or whatever other adjustment is provided, until the distances AD and BD to which the arm travels to either side of the center are the same.

On the stud which carries the wrist plate will be found three marks like BCD in Fig. 3, and upon the wrist plate a single mark like that at A. Hook in the rod which connects the wrist plate with the rocker arm, turn the engine slowly and adjust the stub-end upon the hook rod until the mark A goes out to both C and D, and does not travel beyond either. This does the same thing for the wrist plate which has previously been done for the rocker arm.

A diagrammatic representation of the cylinder and the crank and eccentric is given in Fig. 5. The connecting mechanism can be imagined. The eccentric is set, as you know, something more than 90 degrees ahead of the crank. Disregarding the slight distortion due to the angularity of the eccentric rod, the wrist plate will be in its central position when the eccentric is on the quarter, or in a position at right angles to the axis of the engine, at which time the crank will be approaching the center but some distance away. When the shaft has turned halfway around and the eccentric is again perpendicular to the engine axis, the wrist plate will again be in its central position, and the crank will be in the same position with regard to the other center, so that the position of the valves when the wrist plate is on the center must be the same for both ends.

The piston has not yet reached the center; it is too early to open the steam valves, so that for this position of the wrist plate they should have some lap. With the exhaust valves we encounter conflicting conditions. The stroke is uncompleted but nearing its end. In one end of the cylinder the expanding steam must be released if we want a free exhaust; in the other the exhaust valve must be closing if we want compression. We have just seen that in the central position of the wrist plate the valves must be set alike on both ends. Now if we set this exhaust valve closed to get more compression, we must set the other one with an equal amount of lap, and may hamper the release upon that end, and if we do not set it the same it will be at the same disadvantage with regard to compression that we are trying to correct in this valve. Further, the very lap which we are putting onto this valve to get compression will be in the way when we are trying to open this valve early for release.

The best that can be done with an engine in which the motion for all four valves is taken from a single wrist plate is to compromise between the release and the compression. Set it for as little compression as you can get along with, which will be doing the best you can for the release. With a non-condensing engine a very good distribution can be gotten in this way, as neither the release nor the closure for compression has to be so early as in the condensing engine, where there is a considerable drop from the terminal to the vacuum pressure and an early release is imperative if the toe of the diagram is to be kept down and the full vacuum area realized; and where it is necessary to close the exhaust valve early in order to compress the thin vapor of the vacuum to a pressure which will arrest without shock the momentum of the moving parts. For the ordinary condition the exhaust valves of such an engine should be open from a thirty second to three sixteenths, for engines up to 42 inches in diameter, when the wrist plate is in its central position. Tables of lap for the steam valves and of opening for the exhaust valves are published in various books, or can usually be obtained from the builder for the particular engine in hand.

If you take off the back bonnets you will find something like Fig. 6. The little marks at J and K show the positions of the working edges of the port and valve, as shown in Fig. 7. With the steam valves hooked on put the mark on the wrist plate in line with the central mark on the stud, and if your previous work has been accurate, the wrist plate will be in its central position. Now lengthen or shorten the connections between the steam valves and the wrist plate by means of the right and left connections until the distance between the marks J and K are equal to the desired lap. K should stand with reference to J so that it will move toward it on the opening movement of the valve. Some builders make their valves open toward and others away from the cylinder. Adjust the exhaust valves with the desired opening in the same way. For every material change in the length of the steam-valve connections there must be a corresponding change in the length of the dashpot rods. If they are left too short the valves will not hook up, and if they are too long the closing shoulder on the moving member of the steam-valve operating mechanism will bring up against the block before the wrist plate has reached the end of its travel, and something will have to bend or break. Make the length such that when the dashpot piston is thoroughly bottomed the valve will hook on easily and still so that there is plenty of clearance for the closing block, dividing the leeway substantially equally between the two. Now hook on the eccentric, put the engine on either center and turn the eccentric ahead of the crank in the direction in which the engine is to run until the steam valve has the desired amount of lead. If the work has been accurate the lead will be the same on the other end.

The position of the eccentric ahead of a right angle with the crank is called the "angular advance," and it is desirable to keep this as small as possible, first, because the motion of the eccentric available for opening the valves becomes sluggish as it gets away from the quarter, and it is desirable to have the valve opened sharply, and, secondly, because by increasing the angular advance you decrease the range through which the engine can cut off. The cutoff is effected, as you know, by the contact of the releasing mechanism with the little cam, the position of which is controlled by the governor. The releasing mechanism is pushed toward this cam by the wrist plate as it moves away from its central position. If the contact does not occur on this outward movement it cannot occur at all during that stroke for when the wrist plate starts back it is drawing the mechanism away from the cam.

It is evident that this outward movement of the wrist plate in either direction occurs only during one quarter of the revolution of the eccentric, and if we use up a large proportion of this quadrant in angular advance we shall have so much less of a range through which the governing mechanism is effective, and the earlier in the stroke will the engine commence to hang on.

All of the above applies to the admission valves. For the exhaust valves, on the contrary, considerable angular advance would often settle an awkward conflict between the release and the compression. I have pointed out before that if you add lap here to make the valve close earlier and get more compression, the lap will be in the way when you want to open the valve early and get a free release. But moving the eccentric ahead makes everything earlier and would quicken both release and closure for compression. So here is another compromise which we must make, this time between admission and exhaust. The position of the eccentric is determined, in the directions which I have just given you, by the lap which is given to the steam valves, because you set the eccentric ahead until with that lap the engine has the desired amount of lead, and this is the controlling factor in making up the tables to which I have referred.

In 1884, W. E. Crane, at that time in charge of the steam plant of Benedict & Burnham, at Waterbury, Conn., hit upon the idea of using a separate eccentric for the exhaust valves. In writing of this experience Mr. Crane says:

"I placed the two wrist plates in a vertical position and connected the steam valves so that each had 1/16-inch lead. The exhaust valves were given 1/8-inch lead. The eccentrics were placed at right angles to the crank and connected up. The steam eccentric was fastened to the shaft in that position, while the exhaust eccentric was advanced about 30 degrees.

"The engine had a cylinder 28 inches in diameter, and an attached condenser with a vacuum of 28 inches. Setting the steam valves in the above manner enabled me to get a range of cutting off from 0 to ¾-stroke, which made regulation very close, and very slight speed change in irregular work. The exhaust valves opened sufficiently early to get full vacuum at the commencement of the stroke and also had sufficient compression.

"With a non-condensing engine it is not necessary to advance the exhaust eccentric more than about 20 degrees. On a compound engine I have given the low-pressure steam valves ½-inch lead and not found it too much. With valve stems, as usually splined, it will not be possible to set them as indicated above. If you have an engine just building, the valve stems can be splined that way in the first place.

"With stems already in use it will be necessary to take the stems out, turn them over and make new keyways. With the old style, where the blade was laid in a slot in the valve, it will require an offset key, or some other method of arranging the key, to get the above results."

It now remains to adjust the governing mechanism. The three essentials are that the valves shall not be able to hang on long enough to give the engine steam when the governor is in its highest position in order that the governor may be able to prevent the engine from running away when there is no load, that the valves may not hook on at all when the governor is in its lowest position in order that the engine may not get steam and run away in case the governor belt breaks or the governor becomes otherwise deranged, and that the cutoffs be equalized between the two ends on the average load. It is not possible, with the usual arrangement to so adjust them that they will be equal for all loads, for the movement of the piston, due to the angularity of the connecting rod, is different in the two ends of the cylinder, while the motion of the wrist plate, due to the much smaller angularity of the eccentric rod, is much more nearly equal on either side of its central position. The governor in descending a certain distance moves the knock-off blocks back an equal distance on both ends, and the piston has to move further in one end of the cylinder to turn the crank and the eccentric far enough to make the wrist plate push the releasing mechanism up against the cam in one end than in the other. This difference varies for different parts of the stroke, so that if it is corrected for one point of cutoff the correction will not be right for another.

The different angularity of the governor rods is also a feature. It would seem as though some simple mechanism might be interposed to make the movement of the cams vary in the same way as that of the piston, and I recommend it to you as a field for the exercise of your ingenuity. In the meantime the best we can do is, as I have said, to equalize the cutoffs for the average load. Perhaps the best way to go about it is to block the governor in its highest position, and adjust the length of the governor rods so that when the wrist plate is worked with the bar the hook will let go of the valve before the steam port gets open, which will be when the wrist plate has passed the central position a very little, for you will remember that the tables call for the valve to be lapped some when the plate is at the center of its travel.

Now, if you cut off usually, as you should, at about quarter stroke, place the engine in that position, block the governor up to its normal running position, hook the wrist plate in and adjust the governor rod of the end which should just be cutting off so that the cam will be in contact with the releasing mechanism. Turn the engine over until it has made one quarter of its stroke upon the other end, and repeat the operation. Now block the governor in its highest position and see that you have not allowed the engine to get steam under that condition. If you have, you must take care of that point. Perhaps you can do so by raising the collar which confines the upward movement of the balls. If not you must choose a higher position for the normal. If everything is all right, adjust the safety cams so that they will prevent the valve from hooking on at all when the governor is in its lowest position.


Before the Start at Argenteuil.


André Beaumont in the Pilot's Seat.

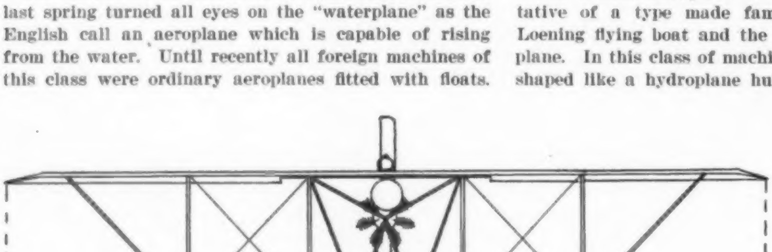
The Donnet-Lévêque Hydro-aeroplane

Description, With Scale Drawings, of the Most Successful French Flying Boat

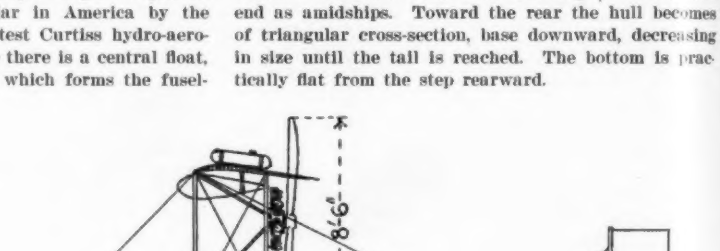
By John Jay Ide

The success of the Monte Carlo hydro-aeroplane meet last spring turned all eyes on the "waterplane" as the English call an aeroplane which is capable of rising from the water. Until recently all foreign machines of this class were ordinary aeroplanes fitted with floats. Within the last few months, however, a new hydro-aeroplane—the Donnet-Lévêque—has been produced in which the nautical portion is one of the essentials of the machine and not an after thought.

The Donnet-Lévêque is the only European representative of a type made familiar in America by the Loening flying boat and the latest Curtiss hydro-aeroplane. In this class of machine there is a central float, shaped like a hydroplane hull, which forms the fuselage. In the Donnet-Lévêque the hull contains the pilot, passenger and control gear and, at the stern, the empennage, elevator, and rudder. This hull has a single pronounced step forward of which the sides are almost vertical. Thus the width is almost as great at the fore end as amidships. Toward the rear the hull becomes of triangular cross-section, base downward, decreasing in size until the tail is reached. The bottom is practically flat from the step rearward.



Front Elevation.



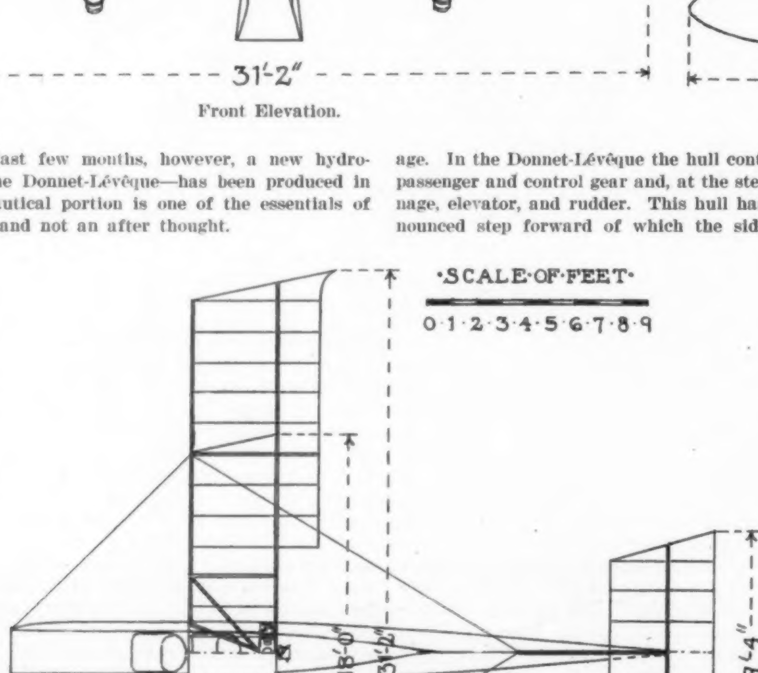
Side Elevation.

There is an open cockpit with room for two persons. The pilot is placed just forward of the leading edge of the planes, and the passenger sits immediately behind him, the lower plane being cut away for the purpose. Forward of the pilot is a water tight compartment and another similar compartment is placed just astern of the passenger. Since the whole hull is decked over, with the exception of the cockpit which is just large enough for the two occupants, the apparatus could not be swamped even in rough water. The hull is constructed of three-ply walnut planking.

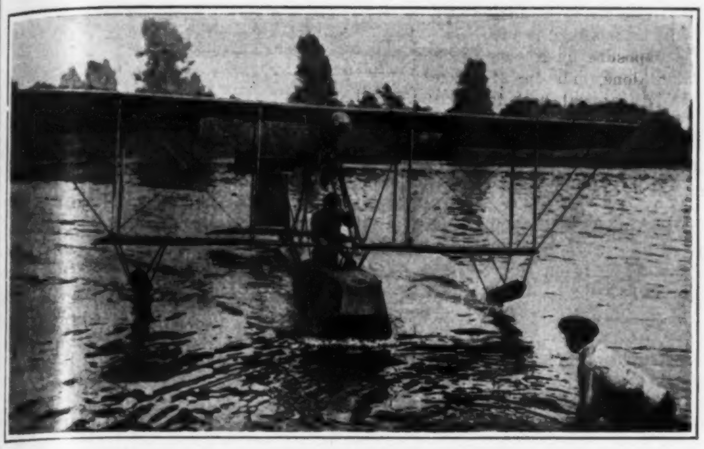
Since the pilot has only about five feet of deck in front of him, he enjoys a very clear view. His controls comprise a universally-jointed steering column with automobile type of wheel working the elevator and wing warping, and a foot-operated horizontal bar for the lateral rudder.

The aeroplane is attached to the hull by two pairs of wooden stanchions of large section, each pair forming a V. The lower extremities of the stanchions are fastened to the keel of the hull. The upper extremities are received in steel sockets bolted to the main transverse members of the lower plane. The plan form of the wings takes the shape of a trapezoid with the larger base toward the rear, thus avoiding marginal losses. Under either extremity of the lower plane is a small cylindrical float to prevent the wing going under when the machine rolls in rough water. At the rear of each float is a flat trailing strip.

There are four pairs of main uprights between the two bearing surfaces made of wood of oval section. In addition to these there are two steel tubes immediately above the fuselage connecting the forward wing spars of the two planes, and four more between the bases of the outer uprights and the overhang of the upper plane. The motor, a Gnôme, is carried in a special framework between the planes. This framework is held in position by an arrangement of steel tubes forming two triangles with the lower and upper rear wing spars as their bases. To support the forward extremity of the engine shaft a second triangular arrangement of steel tubes springing from the front spars is employed. The



Plan View.



Lieut. Conneau's Hydro-aeroplane in Which He Made Some Remarkable Flights in France.

Lieut. Conneau (André Beaumont) in Flight Over the Seine in His Donnet-Lévêque Hydro-aeroplane.

axis of the motor is in a position about two thirds of the distance from the lower to the upper plane; the exact position has been determined only by a considerable amount of experiment. There is very little clearance between the heads of the cylinders and the upper plane the rear part of which is here cut away to allow room for the direct-driven propeller. The gasoline tank, of streamline form, is suspended just below the forward part of the upper plane, and the oil tank is just above it on top of the bearing surface.

The empennage consists of a slightly cambered fixed stabilizing plane and a one-piece elevator with lateral edges shaped like those of the main planes. Forward of the rectangular lateral rudder is a triangular fin resting on top of the fuselage which at this point is of purely triangular section.

The Donnet-Lévêque is at present made in two types: Type A driven by a 50 horse-power Gnôme and to which the accompanying drawings refer; and Type B, driven by an 80 horse-power Gnôme.

The characteristics of Type A are as follows: Span, 31 feet 2 inches; length, 28 feet 10 inches; wing area, 183 square feet; weight, 700 pounds; speed, 69 miles per hour.

The only structural difference between Types A and B is the employment of ailerons for lateral balance in the latter instead of wing warping.

The characteristics of Type B are: Span, 34 feet 1 inch; length, 27 feet 10 inches; wing area, 225 square feet; weight, 850 pounds; speed, 75 miles per hour.

Both of the above types carry only one passenger in addition to the pilot, but there is now under construction a third type having greater area and a wider fuselage accommodating four persons in two pairs.

. . . . . .

Several fine journeys on these machines have been accomplished by André Beaumont, the winner of last year's three great cross-country races. When the removal of the Donnet-Lévêque hangar from Port-Aviation at Juvisy to Bezons was decided upon, Beaumont resolved to transport the two machines housed at Port-Aviation by way of the air. On the 26th of July at 5:50 A. M., he left the aerodrome on the 80 horse-power machine and descended the Seine to Bezons, where he landed at 6:20, having taken 30 minutes for the 35 miles and made a speed of 70 miles an hour. In the evening he made the same journey with Capt. Koster as passenger in the 50 horse-power machine.

Beaumont's greatest exploit on the Donnet-Lévêque was his attempt to reach London from Paris by flying over water all the way. The start was made on August 9th at Argenteuil on the River Seine, where the firm has its factory. In order to shorten the total distance it had been decided to cut straight across country from Paris to Havre instead of following all the windings of the Seine. On this account the machine was fitted with a pair of wheels under the hull just abaft the step.

At 4:30 A. M. Beaumont left the ground, and after a short circular flight, made a straight course for the sea. A landing of fifteen minutes was made at Quillebeuf at 6:40 in order to take on more fuel and oil. At Havre, which was reached at 9 o'clock, the wheels were removed. At 1:50, after luncheon, the journey was continued along the coast to Boulogne, the port of which was gained at 3:45. On landing the right wing-tip was slightly damaged, making it necessary to postpone further flying.

Next morning after repairs had been made, Beaumont attempted to cross the Channel, notwithstanding the strong wind and choppy sea. The pilot got off the water quickly, but then made the mistake of attempting a steeply banked turn before attaining sufficient height. With the wind astern he swept down at a speed of 75 miles an hour for the motor was running at its full speed. The hull struck the water violently, the bow breaking open under the shock. The fore compartment filled and the whole forward portion of the fuselage sank. The hull was one of the earlier types, which had undergone modifications having some of its members patched up. This, however, was not responsible for its breakage as even a steel plate might have given away under the terrific impact with the water. The accident served to show the safety of the hydro-aeroplane, for although the pilot was carried entirely under the surface of the water and held down for a few seconds, he received nothing worse than a wetting. Such a landing on *terra firma* would undoubtedly have had fatal consequences.

Playing Tennis at Night*

On Gas-lighted Open-air Courts

By T. J. Litle, Jr.

Experiments have been conducted over a period of several months to determine whether or not it would be practical to play lawn tennis at night on courts lighted by gas. These experiments have culminated in an installation where four tennis courts are lighted at the Woodbury Country Club, Woodbury, N. J.

The lighting of a single court would not be adequate for a country club, because so few of the club members would take advantage of the court during the evening; therefore, it could not be considered popular from the standpoint of the general membership; consequently, where single courts have been lighted, it is found that they are used but one evening a week for tournament playing. Where more than one court is lighted the illumination becomes more economical, as the light over one court contributes to the illumination of the adjoining courts. Where several courts were lighted, the game became very popular.

The lighting of single private tennis courts, for use in playing this game, however, is perfectly feasible.

It has been found at Woodbury that the courts are patronized on an average of three hours an evening, with all courts filled and a number on the waiting list. A number of players interviewed declared that they enjoyed night tennis immensely more than day tennis for the reason that in the cool of the evening they did not become so easily fatigued. From the social standpoint it can be considered an instant success to any club adopting it. There are a large number of auto-

* Reproduced from *Good Lighting*.

Day View.

Night View.

mobiles parked along the courts every night watching the game. Tennis is becoming very popular in America; so much so that it becomes difficult for the average business man to enjoy the game even on Saturdays and holidays, the courts being in such great demand, and it was with the idea of remedying this situation that night tennis was considered.

The nominal charge of 10 cents per hour per player will more than take care of all expense incidental to the operation of the lamps.

Cost of Operating Two Courts for 1 Night.

Cost of gas at $1 per M—24 lamps (18 cubic feet per lamp) three hours per night	$1.29
Maintaining 24 lamps at 50c. per month ($12 for 25 days)	.48
Total for two courts for 1 night	$1.77

Revenue from Two Courts for 1 Night.

8 players—3 hours, at 10c. per hour............ $2.40

When the proposition of supplying gas for night tennis was put up to the gas company they agreed without a moment's hesitation to run over 200 feet of 3-inch main, realizing that here was a new use for gas which promises to be very popular before the end of the present season.

The night photograph shows the remarkably high and uniform illumination obtained. In taking the picture it required but 1½ minutes exposure on a very dark night, by the light of the lamp alone. The installation is designed to include standard material, both in lamps and piping. Any pipe shop can turn out the work promptly. The installation shown in the photograph was made in two days, all the pipe being cut in the pipe shop and the poles being assembled and erected on the ground.

It will be noted that, with the exception of the pole alongside of the net posts, there are no poles near the side lines, the mast arms extending far out from either side of the central poles taking the place of objectionable side poles.

As shown, the poles are made up of standard pipe imbedded in concrete, each pole extending 3 feet below the surface. The gas is taken into the pole 1 foot below the surface, leaving a 24-inch drip at the base of each pole. A plug outlet is located at the ground level so that a rubber hose may be inserted for pumping out the drips on each pole. The pipe line is, of course, dripped to the meter, which is located in the basement of the club house about 100 feet from the court. The posts are painted white, to match the white and gold five-burner gas lamps with which this installation is equipped. Lamps are all hung on ball joints which insures them hanging perfectly vertical and which are found by experience to absorb vibration satisfactorily.

It will be noted that 16 lamps are required to light a single court but where the courts are immediately alongside of each other the number of lamps may be greatly reduced, as follows:

1 court, 16 lamps, gas consumption 288 cu. ft. per hr.
2 courts, 24 lamps, gas consumption 432 cu. ft. per hr.
3 courts, 32 lamps, gas consumption 576 cu. ft. per hr.
4 courts, 40 lamps, gas consumption 720 cu. ft. per hr.

In the installation shown above only two courts out of four were to be lighted, but when the installation was made it was found that the entire four courts could be used, the center two courts, of course, being better illuminated.

It must be apparent to anyone that night tennis by gas light is an extremely attractive proposition to the gas man. It brings gas lighting into prominence, and as such is valuable publicity advertising. There are hundreds of country clubs located in or near the large cities and suburban towns that will be interested in night tennis.

On Cooked Foods*

The Economics of the Dinner Table

By Katherine I. Williams, B.Sc.

In this article the question of foods, especially cooked fish, vegetables and cereals is dealt with from the chemical point of view.

For many years the author has been engaged upon the investigation of the chemical composition of such food materials, and the suggestion has been made that the general public, and not only the chemical world, might be interested in this important subject. In America the question is brought before the public to a much greater extent than it is in England: a great deal of valuable information has been published there. Congress has granted money to the Department of Agriculture, bulletins on the subject are distributed freely, and several of the so-called Farmers' Bulletins deal with the uses of milk, fish, eggs and other ordinary kinds of nourishment.

It is hardly necessary to state that to be of real value all such investigations must be quantitative: that is, must show in percentages the amounts of the various constituents present. The first recorded quantitative analysis of any food was made in this country by George Pearson in 1795, who determined the proportion of water, starch, ash, fiber and extractive matter in kidney potatoes. For about eighty-five years similar work was carried on in Europe, chiefly in Germany. Since then many American chemists have devoted themselves to this subject. Bulletin No. 28 (Office of Experiment Stations, Department of Agriculture), prepared by Prof. Atwater and A. P. Bryant, entitled: "The Chemical Composition of American Food Materials," contains details of the analyses of four thousand and sixty American articles and commodities used for human food in that country, but in most cases the food is uncooked.

During the last few years Prof. Grindley, in the University of Illinois, and others have devoted themselves to the study of the effect of various methods of cooking meats.

It is well to understand what is meant by food, and the definition given by Dr. R. Hutchinson in "Food and the Principles of Dietetics" is perhaps the simplest that can be given, "anything which, when taken into the body, is capable of either repairing its waste or of furnishing it with material from which to produce heat or nervous and muscular work." Other substances may have a useful place in our dietary, though not falling into the category of food-stuffs. Later on it will be seen how various commodities answer to this description. The ordinary articles of diet are mixtures of various chemical substances, some of which are of value as nutrients, others are not. Of the former the most important are the nitrogenous; as the name implies, they all contain nitrogen. They are known under various names: gluten in bread, legumin in the pulses, but are commonly spoken of as the proteins.

Non-nitrogenous is a general name for the carbohydrates, starch, sugar, and so on, also the fats, such as butter. Table salt and other mineral matters, and water, are also of importance; the latter is not only contained in the liquids we drink, but also forms part of the solids we eat.

* Reproduced from *Knowledge*.

The main object of the investigations now to be considered was to arrive at a clear idea of the value of foods as served at table, and the results show that many wrong impressions exist as to the proportion of nutrients they contain.

In commencing the study of a food, the first stage is to weigh the sample; then, if it is fish, it must be cleaned, the scales scraped off, the refuse weighed; with such vegetables as cabbage and broccoli the outer leaves must be removed; the pods of peas and beans all come under the head of refuse; the pods, however, have a value for soup. With potatoes the skins should not be removed before boiling, as valuable salts are mainly found in the layer just under the peel.

Waste before Cooking.

In 100 parts.

Food	Refuse	Food	Refuse.
John Dory	21¼	Spinach	25
Gurnet	9	Green Artichokes	72⅓
Broccoli	68	Green Peas ...	45

The sample is again weighed, and cooked, and is then in the condition in which it would be served at table. It is then re-weighed to ascertain the increase or decrease in the amount of water gained or lost.

All waste is removed, such, for instance, as the bones and head of fish, the hard part of asparagus. With cereal foods, on the other hand, there is no refuse.

Refuse as served at Table.

Name	Refuse.	Name.	Refuse.
John Dory ...	21	Haddock... ...	35
Salmon (section)	6	Asparagus ...	34
Herrings... ...	12	Green Artichokes	69

We now pass to the main question, what is the value of the edible portion of the various cooked foods? And the first point to consider is the amount of water, which is most important, as we could not live on dry foods; but, on the other hand, it is clear that a high percentage of water will result in a bulky food. During the process of cooking, meat and fish decrease in weight; in almost every case vegetables increase, and cereals always do so.

Unfortunately, details were not kept as to the weight of the fish before cooking, but as will be shown, the percentage amount of water is lower in the cooked than in the uncooked samples.

With regard to meat it is stated that however cooked it loses from one fifth to one third of its weight.

Johnston found:

	In Boiling.	In Baking	In Roasting.
4-lbs. of Beef lose in weight ...	1-lb.	1-lb. 3-ozs.	1-lb. 5-ozs.
4-lbs. of Mutton lose in weight ...	14-ozs.	1-lb. 4-ozs.	1-lb. 6-ozs.

Prof. Grindley observed that on boiling lean beef it lost forty-four and two thirds per cent of its original weight; at a temperature of 85 deg. Cent., a similar sample boiled in boiling water lost forty-five per cent. He found, further, that beside losing water, some of the fat, mineral matters and protein are dissolved out at the same time, and on examining the extracts he found as the average of ninety-one samples that the loss of mineral matter was forty-four and a half per cent of the total amount present in the meat, of fat twelve per cent, and of protein seven and a quarter per cent. In the process of stewing, highly flavored soluble matters are removed from the meat and transferred to the bouillon.

At the same time comparing the nutrients in cooked and uncooked meats, we find a higher percentage of nutrients in the cooked condition and a lower percentage of water.

One great difficulty that confronts the food chemist is the material he works with: individually one sheep is not exactly like another, one may be fatter, another leaner; so with fish, vegetables and cereals. It is stated by Prof. Snyder that in the case of flour containing twelve per cent of moisture, if one hundred pounds be kept in a dry place a reduction of three pounds in weight may be observed, whereas in a damp place a corresponding increase may take place. Therefore, in this class of analysis only approximations can be made, and it is important to obtain as much information as possible, repeating the examination of articles of food, and taking the mean of a large number of analyses.

Thus, with three samples of uncooked American halibut it was found:

Edible Portion.	Water.	Protein.	Fat.	Ash.
Minimum	70	17¼	2·0	1·0
Maximum	79	20	11·0	1·1
Average	75	19	5·0	1·0

Six samples of mackerel were also analysed:

Edible Portion.	Water	Protein.	Fat	Ash
Minimum	64	17½	2	1
Maximum	79	19½	16	1¼
Average	73	19	7	1

When first the work with vegetables was started it was impossible to judge how much vegetable was required: in three cases the supply fell short, and fresh samples had to be prepared the following year, giving very different results on the dry basis for protein.

	Sea Kale.	Parsnips.	Potatoes
I.	41	12	13
II.	27	15	11

These data confirm the fact long known, that the nitrogenous compounds vary (a) with the maturity of

the plant (*b*) variety of the plant (*c*) soil and cultivation (*d*) the season. In our present state of knowledge we assume all the nitrogen of our foods exists in the form of protein, but research is showing that some is present as non-proteid; further, that proteids differ considerably from each other: one form is found chiefly in nuts, another in meat. Often a mixture of various kinds is present, and the important question of the replacement of one form by another is being investigated by Dr. E. F. Armstrong and others. One important point requiring investigation is the question of loss in the cooking of vegetables. Whenever possible they should not be cooked in an excess of water, which it is necessary to drain off afterward. Prof. Snyder, at the University of Minnesota, made a study of the loss of nutrients in potatoes, cabbages and carrots; he states that one hundred pounds of uncooked cabbage only contain seven and a half pounds of solid matter, and of this two and a half to three pounds are lost in cooking, the loss consisting of protein, mineral matter and carbohydrates. With carrots cooked in small pieces twenty per cent to thirty per cent of the total food material is extracted; the average of seventeen American analyses shows only eleven and three fourths of solid matter, while the average of thirty-five European analyses shows thirteen and one fifth, and of this from two and a half to four pounds (mainly consisting of sugar, mineral matter and protein) is lost.

With potatoes it was found that the loss suffered on boiling was inconsiderable, provided they were unpeeled. With spinach we have only ten pounds of solid matter in one hundred pounds; when drained after cooking the loss is two and a quarter pounds. Celeriac nine and a half pounds solid in one hundred pounds, and the average of three samples shows that four and a half pounds are lost. Borecole, or curly greens, one hundred pounds contain ten and one third solid, and of this five and a quarter pounds are lost. Turning to a still more common article of food, rice, it is frequently boiled in an excess of water, which is then drained off. In this process protein, fat and mineral matters are lost. Now rice contains but very little of these nutrients to start with, and in the East the native soldiers prefer to have the liquid which has been drained off, and leave the residue for the English soldiers. All this loss can be avoided by boiling the rice (according to the American receipt) in two and a half times its bulk of water for twenty minutes, then placing the saucepan on a tripod, covering it with a piece of cheese cloth, and allowing it to remain covered for an hour; at the end the rice will be tender and sweet. As a rule all vegetables, except in a very few cases, weigh more after cooking; all show a high percentage of water; so, in the case of loss of weight it must be due to the loss of nutrients. This increase of weight tends to make all vegetable and cereal foods bulky. One hundred ounces of green artichokes after cooking weigh three hundred and thirty-six ounces; one hundred ounces brussels sprouts, one hundred and twenty-one ounces; leeks, one hundred ounces become two hundred and fifty-two ounces; one hundred ounces lentils, two hundred and thirty-eight ounces; one hundred ounces arrowroot, one thousand one hundred and fifteen ounces; one hundred ounces quaker oats, one thousand one hundred and ten ounces; one hundred ounces mother's oats, nine hundred and twenty-five ounces; one hundred ounces rice, four hundred and eighteen ounces.

The percentage of water is one of the most important points in food analysis; we want to know how much solid food we really consume. Considering meat and fish there is a higher percentage of solid matter, and the whole of the flesh consists of nutrients, fat, protein, and mineral matter. But in vegetable and cereal foods, on the other hand, besides these nutrients there is a framework of cellulose or woody fiber; according to some authorities this has a value from the food

TABLE SHOWING PERCENTAGE OF WATER AND SOLIDS IN VARIOUS ARTICLES OF FOOD BEFORE AND AFTER COOKING.

Name	Cooked		Uncooked	
	Water.	Solids.	Water.	Solids.
Beef	57	43	71	29
Mutton (leg)... ...	51	49	63	37
Lamb	67	33	72	28
Veal (cutlets) ...	58	42	72	28
Cod	76	24	82	18
Haddock	68	32	78	22
Lentils	66	34	12	88
Green Peas	87	13	75	25
Dried Peas	62	38	14	86
Onions	99	1	82	18
Carrots	93	7	86	14
Cabbage	97	3	89	11
Vegetable Marrow ...	99	1	95	5
Rice	81	19	13	87
Quaker Oats ...	92	8	13	87
Arrowroot	93	7	16	84

point of view, but it is doubtful. In the process of cooking the framework is ruptured, and the starch inside is gelatinized; the change may be observed in well-cooked potatoes.

The table shows the effect of cooking as regards the percentage of solid matter in the cooked and uncooked articles: increase in nutrients in the case of fish and meat, decrease in solids with vegetables and cereals following the cooking process. Only edible matter is considered: that is, the flesh of the meat and fish, and the portion of vegetables that can be eaten as food.

At this stage it is possible to judge which foods, bulk for bulk, contain most nutrients, but this does not conclude the matter; for it is further necessary to know the nature and the percentage of each nutrient. The human body requires certain amounts of fat, carbohydrates (that is, starch and sugar), mineral matter and protein daily. Protein can fulfil the functions of food in all respects as a tissue former, and also yields heat and energy, with the help of water and mineral matters, that is, salts such as sodium chloride or table salt; but under ordinary conditions fats and carbohydrates are necessary as energy-producers. Studies as to dietaries have been made in England, America, Germany, Sweden, Russia, and Japan among various classes of people, those doing hard and moderate work, factory operatives, tailors, college football teams, those employed in intellectual work, soldiers in time of peace and war. Taking the average, they conform fairly well to the standard drawn up by Prof. Atwater: four and a half ounces protein, sixteen ounces carbohydrates, and four and a half ounces fat for a man doing moderate work. To a certain extent fat and carbohydrates can replace each other, and it is estimated that for every part of protein four and three quarters of carbohydrates and fat are required. It is understood that this standard is for the average man; in the case of woman, four fifths of the above amounts is sufficient, and children require less in proportion to their age.

At the present time there is a good deal of discussion on the question of proteid, and experiments have been made by Prof. Chittenden, of Yale, and others, who state that the human body only needs about half of the amount mentioned above, even two ounces are stated to be sufficient; but until more is known, Prof. Atwater's or similar standards will hold their own.

Now, the results of analysis can be stated in two ways, and one of these has led to the many false ideas which at present are in circulation among the general public. The dry powdered sample must be used for the estimation of fat, and so on, and in many books results are stated on this basis, and the important factor, viz., the percentage of water present is left out of the question. The other and correct method is to give tables including the water and calculating the fat, and so on, in the natural moist condition of the food as actually eaten. The two following tables will illustrate the false and correct method of describing the results of analysis.

DRY POWDERS.

(Analyses from which false deductions can be drawn.)

Names.	Mineral Matters.	Protein.	Fat.	Carbohydrates.	Fibre.
Oswego	1	23	—	76	—
Quaker Oats	3	22	4	83	1
Mother's Oats ...	2	12	4	85	1
Lentils	2	26	½	68	2
Peas	2	25	2	61	6
Brill	4	94	2	—	—
Halibut	4	80	16	—	—
Herrings	6	67	25	—	—
Beef (Boiled) ...	3	80	17	—	—
Veal (Roasted) ...	3	68	27	—	—
Mutton „ ...	2	51	46	—	—

NATURAL MOIST CONDITION—AS SERVED AT TABLE.

(Correct Method of Analysis.)

Names.	Water.	Mineral Matters.	Protein.	Fat.	Carbohydrates.	Fibre.
Oswego ...	87	—	3	—	9	—
Quaker Oats...	92	¼	2	⅓	6	—
Mother's Oats	90	—	2	½	9	—
Lentils ...	66	⅝	9	—	23	⅔
Peas	62	⅝	9	⅓	23	2½
Brill	63	2	35	½	—	—
Halibut ...	74	1	20	4	—	—
Herrings ...	60	2	26	10	—	—
Beef (Boiled)	57	1	34	7	—	—
Veal (Roasted)	58	1	29	12	—	—
Mutton „ ...	51	1	25	23	—	—

One of the most important factors to consider is the amount of protein present in the food. In books treating of the subject the statement is often found that the pulses are rich in this nutrient, and for this reason are called "poor man's beef." Analysis clearly shows that such statements are entirely incorrect. But to understand why this view has been put forward it is only necessary to study the following table, which shows the composition of some of these foods in the uncooked condition, i. e., not in the conditions in which they are eaten.

APPROXIMATE COMPOSITION OF UNCOOKED FOODS IN THE NATURAL MOIST CONDITION.

Names.	Water.	Mineral Matters.	Protein.	Fat.	Carbohydrates.	Fibre.
Beef	71	1	22	4	—	—
Veal	71½	1	20	6	—	—
Mutton ...	67	1	20	12	—	—
Lentils... ...	12	3	22	1	2	59
Peas (dried) ...	14	2	21	2	6	55

The samples used are the same as those analysed in the cooked condition, with the single exception of mutton. When these tables are compared it is seen that in the uncooked condition the protein of the sample analysed is nearly the same, but when served at table there is an enormous difference; the lentils and peas which before cooking contain twenty-two per cent and twenty-one per cent contain after cooking only nine per cent, and while beef containing twenty-two per cent rises on cooking to thirty-four per cent, veal from twenty per cent, to twenty-nine per cent; even on the basis of the cooked dry powder the amounts of protein present show that pulses cannot yield the same amount of protein as meat. The reason of this great difference is, of course, the change in the amount of water after cooking, a loss in the case of meat, and a large gain in the case of vegetable foods as will be seen by consulting the first of the accompanying tables.

A new campaign has arisen lately whose watchword is "Fish as Food." From what has been stated the amount of protein is satisfactory; but the difficulty is to get a really fresh supply, as when not fresh it is hardly a wholesome form of food, and to be avoided when served with various sauces to conceal the unsavory smell in a stale condition. Many base their praise of fish on the idea that fish is an excellent brain food because it contains phosphorous, but Dr. Hutchinson, in "Food and the Principles of Dietetics," says: "It has never been shown that an increased supply of phosphorous in the food is specially favorable to mental effort, nor, indeed, has it been proved for any other food." But even if it were true that phosphorous is such an important point, a fish diet could be of no value, for the amount of that substance present is so extremely small.

As served at table the edible portion of herring only yields one fiftieth per cent, sprats one sixth per cent, trout one seventh per cent, and turbot one tenth per cent in each case. Atwater made investigations on the same point on raw fish with a similar result.

The work of the food chemist is to analyse food materials, so that those more competent can draw up suitable dietaries; but even this is not an easy matter: to get a proper supply of the various nutrients needed, mixed rations are necessary. Lentils are excellent; but if we wish to obtain the full supply of protein from this source, it is necessary to consume one pound one and a half ounces per day (allowing ten per cent for waste of protein in the process of absorption) and this when cooked would amount to four pounds six and a half ounces; one pound five ounces of cooked beef would serve the same purpose, and would be less bulky. The proteid from animal sources is said by most medical authorities to serve the body better as food than that from the vegetable kingdom; the fiber in the latter is also a disadvantage. Some of the everyday mixtures of food have a scientific value: bread and cheese, the former a source of carbohydrates, the latter for protein, bacon and beans, fat and protein, bacon with fowl to supply the required fat. No one food can supply all our requirements, except milk in the case of infants. We can obtain our supply of carbohydrates from two pounds thirteen ounces of bread, but to secure enough protein we should require three pounds fourteen ounces, giving a large excess of starch. With potatoes, eight pounds seven ounces would supply the starch, but twenty-two pounds eight ounces would be needed for the protein, and this would be a very badly-balanced ration.

The money value of a food does not always agree with its true value in the ration: herrings are cheap and contain a high percentage of protein; properly cooked the cheaper joints of meat are as useful as the more expensive. The cheaper forms of arrowroot serve the same purposes as the most expensive. The body gets accustomed to certain foods. In America, for instance, it is said that immigrants from Southern Europe find it difficult to give up their maccaroni, olive oil, and their native kind of cheese, and to take the foods of their new home. Travelers in Switzerland will buy Brand and Bovril and complain of the price, while the Swiss-made Maggi answers the same purpose.

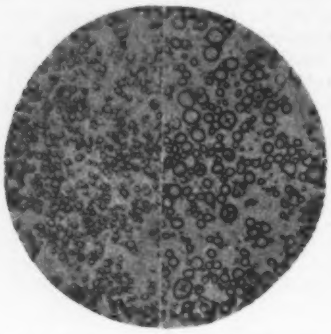


Fig. 1.—Starch Grains. On the Left, Sample of Corn-meal. On the Right, Sample of Rye Flour.

Fig. 2.—Yeast Cells. Comparison of Two Different Varieties. Magnified 700 Diameters.

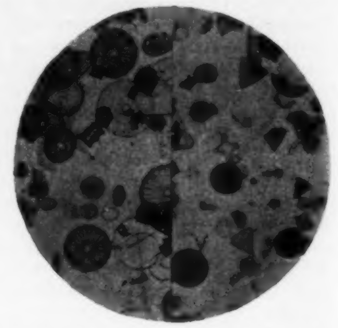


Fig. 3.—Diatom Ooze. On the Left, Sample from Samoa. On the Right, Sample from Kuxhaven.

A Double-Field Microscope*

For the Direct Comparison of Two Objects

By Dr. W. Thörner

The varied requirements of workers in different branches of microscopy have been very extensively met by the highly perfected art of the modern instrument maker. It is a somewhat singular fact, however, that no microscope had hitherto been made which would permit of the simultaneous observation of two preparations, or, in other words, the direct comparison of two objects in the same field of view. Now an instrument of this kind, a "comparison microscope," would be of the greatest value in many scientific investigations. Thus, for example, in the examination of food stuffs for adulterations, it would often be most helpful to be able to compare directly the sample under examination with an unquestionably pure sample of the alleged product. But in many other fields also, in mineralogy, botany, zoology and medicine—to quote only a few—it would be most useful to have at one's disposal a comparison microscope.

Such an instrument, which by the way can be converted into an ordinary microscope by simply sliding a glass prism out of action, is shown in the accompanying illustration, Fig. 4. The light rays are twice turned through a right angle by a suitable arrangement of four total-reflection glass prisms, of which the central two are mounted upon a common sliding piece adapted to be moved into the optical field of the objective. The milled heads *AA* serve for the coarse adjustment, and the micrometer screw *B* for the fine focusing. Any difference in the thickness of the microscope slides carrying the two objects to be compared is compensated by setting the objective heads separately by means of the micrometer screw threads *CC*. The small milled head *D* serves to make the lateral adjustment from right to left of the slide carrying the double prism. By this means the right- or left-hand object alone can, if desired, be viewed in the entire field, or, when the prism-slide is in its central position—as indicated by the snapping of a spring—the two objects appear simultaneously in the field of view, each filling one semicircular area. The appearance thus presented is shown in our illustrations, Figs. 1, 2, 3. The instrument is practically a double microscope, with which all observations made with an ordinary microscope can be made, but which offers the additional great advantage, that at any moment the object under examination can be brought into the field of view simultaneously with a standard object for comparison. An arrangement is also provided, by means of which one object can be viewed by ordinary, the other by polarized light. To do this all that is required is to insert a polarizer in one of the diaphragm openings of the microscope tables, and to place the analyzer over the single eyepiece. The new microscope is furnished with a joint and set-screw so as to allow it to be set at an inclination, and can of course be fitted with all the novel accessories attached to high-class microscopes.

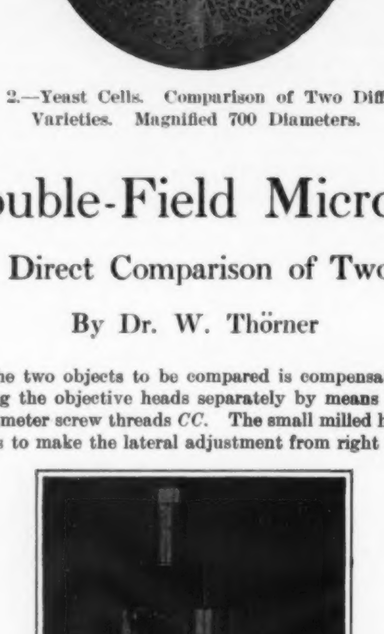


Fig. 4.—Double-field Comparison Microscope.

The accompanying reproductions of microphotographs obtained with the new microscope will give a good idea of the results obtainable with it. The first of these shows in the left half of the field a sample of Indian corn-meal, on the right rye-flour. The second sample shows two varieties of yeast. The third microphotograph illustrates two samples of diatom ooze; on the left a sample from Samoa, at a depth of 100 feet; on the right from Kuxhaven, at a depth of 33 feet.

* Translated for the Scientific American Supplement from *Die Umschau*.

The Solidification of Metals from the Liquid State*

What is the Mechanism of Molecular Aggregation?

By G. T. Beilby, LL.D., F.R.S.

The problem which the committee appointed by the Council, as a result of a suggestion thrown out in my May lecture[1] (1911), proposes to investigate may be stated thus: "Does molecular aggregation occur in liquid metals immediately before solidification either by the formation of liquid crystalline units or by the segregation of globules inclosed in foam cells?"

Quincke has stated that a "foam-cell" structure in the liquid precedes solidification, and that this structure persists in the resulting solid. The liquid separates into two constituents, for even the purest substances contain sufficient impurity to produce a eutectic, and the primary constituent segregates in globules which are kept apart by "foam walls," which are composed of the eutectic or second constituent. As the segregation occurs in the liquid state the question which of the constituents will separate in globules will be settled by their surface tension. Thus an emulsion may consist mainly of globules incased by comparatively thin cell walls, or of a few globules separated in a large mass of liquid.[2]

The present author has shown (May lecture, 1911) that gold globules solidified from the liquid state consist of sac-like grains, which retain their individuality even after very considerable deformation, when, for instance, the globule has been completely flattened by the blows of a hammer.

For convenient reference two of the figures from the lecture are reproduced here. Fig. 1 is the flattened globule showing these sac-like grains, and Fig. 2 is the globule after it has been annealed at about 300 deg. Cent. The structure of the undeformed globule was undoubtedly crystalline, each of the sac-like grains containing only similarly oriented units. On annealing, recrystallization takes place, and the new structure which results is sharply crystalline and quite different from the sac-like type of the primary grains. These observations led the author to ask whether this sac-like structure is to be regarded as due to the persistence of a structure which originated, as Quincke suggests, while the metal was still in the liquid state, or whether it is to be regarded as a direct result of crystallization during solidification. Although the distinction between the two types of crystallization has been referred to more than once, it may be permissible to enlarge on the matter here. Probably many metallographers are familiar with the sac-like type of grains which are occasionally produced under particular conditions of cooling, but the essential difference between this type of crystallization and that which occurs on the recrystallization of a mass of metal which has previously been strained, either by cold working or by local cooling and shrinkage in an ingot or other casting, does not seem to have been so generally recognized. It is, therefore, now suggested that the terms "primary" and "secondary" should be used in describing these two distinct types, at any rate, in all cases where it is desirable to distinguish between them. It is clear that in any inquiry as to the existence and origin of sac-like grains the distinction between these two types must be kept fully in mind. Foam-cell formation, if it occurs, will mainly affect grains of the "primary" type. Crystals of the "secondary" type are probably formed not by the transport of molecules within the mass, but by orientation of molecules *in situ*.

In experimental investigations connected with the present inquiry it will be necessary to produce unstrained crystals of the "primary" type. For this purpose any form of chill or ingot mold would be unsuitable, as cooling and contraction strains can hardly be avoided in these forms of casting. The author has experimented mainly with globules formed by fusion in the blow-pipe flame. Probably the method so successfully used by Ewing and Rosenhain[3] of pouring liquid metal on a flat horizontal surface would in most cases insure that the crystallization of the mass is of the unstrained primary type.

If it be granted that the "primary" crystals are inclosed in cells of some sort, the present inquiry will then take the following form: Are these cells formed at the final stage of crystallization, or are they formed

* Paper taken as read before the Institute of Metals, September 25th, 1912.

[1] *Journal of the Institute of Metals*, 1911, No. 2, vol. vi., page 16.

[2] Proceedings of the Royal Society, vol. lxxvi., A. 431.

[3] Philosophical Transactions, vol. cxciii., A. 1900.

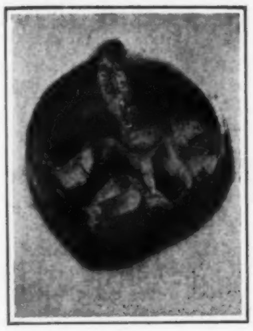


Fig. 1.—Gold Globule with "Primary Grains" Distorted and flattened by Hammering.

Fig. 2.—Gold Globule with "Secondary Grains" Developed by Annealing at 300 degrees After Hammering.

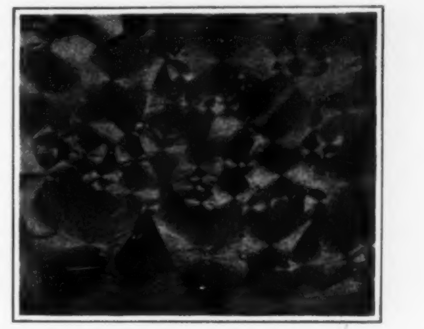


Fig. 3.—Cell-Like Structure Developed by Crystalline Growth from Nuclei in a Thin Film on Glass.

while the metal is still liquid; and, further, if the cell formation is prearranged in the liquid state, are the initial steps due to liquid segregation and surface tension, or to the crystalline aggregation of molecules in the liquid state?

When the process of crystallization is watched under the microscope as it takes place in a thin layer of liquid on glass or other flat support, it appears to start from isolated nuclei, solidification and crystal growth proceeding radially from each nucleus till the radii from adjoining nuclei almost meet. It appears under fairly high magnification as if radii approaching each other stop short before they have actually met, and as if there is formed between them a slight ridge of neutral territory. The effect when all the radii have thus been arrested is as if a network had been spread over the surface, the radii from each nucleus being inclosed by cell-like boundaries. This gives us a picture in two dimensions of what would occur if the layer of liquid was sufficiently deep to permit of similar growth in the third dimension, and we are thus provided with an illustration of a cell structure which is the direct outcome of crystal growth. Though this illustration may not hold in all its details for other types of crystallization, yet something at least analogous to the above must happen. The photograph (Fig. 3) is not magnified, but is, if anything, reduced from natural size. It is not to be expected, therefore, that the microscopic inter-crystalline boundaries should be visible. The figure, however, shows fairly well the features of this type of structure, and in particular it is seen that it is the nuclei which produce the grains. The growth began at the larger and more powerful nuclei; the small grains which are scattered over the surface of the larger grains only started to grow after the latter were well under way. If a growth of this kind be watched from beginning to end, no doubt can be left in the mind of the observer that in this case it is the nuclei which entirely control the ultimate structure. The cell-like structure which has been developed shows no trace of any pre-existing foam-cell structure derived from the liquid film, nor does it appear necessary to postulate the existence of this type of structure. It does not, however, appear to the author that illustrations of this kind are sufficient in themselves entirely to negative the foam-cell hypothesis; they only emphasize the necessity for more positive evidence if the hypothesis is to stand. If the hypothesis is well founded, it ought to be possible to find cases in which the crystalline method of cell formation is controlled, or partially controlled, by the pre-existing structure. Among alloys or slightly impure metals it ought to be possible to find cases in which the pre-existing structure is so robust that it is able to resist or restrain crystalline growth; foam walls which, by their superior rigidity, are able effectively to partition up the whole space before cell-formation from the crystalline nuclei can take effect. In the micro-structure of certain alloys and impure metals surface tension forms, globular, dumb-bell, or rod-like, are often very pronounced; it is possible that the occurrence of these forms may supply a clue which it will be worth while to follow up.

It is not intended that the scope of the present inquiry should be restricted to the proof or disproof of the foam-cell hypothesis. The Council in its remit has indicated a wider range than this, and it is hoped that investigation will be encouraged, not only in the more theoretical regions covered by the work of Lehman, Tamman, Miers, and others on the earliest steps in crystallization, both in the liquid and solid states, but also on the more practical aspects suggested by observations on the influence (*a*) of temperature and (*b*) of mechanical agitation on the molten metal in determining the size and type of the grains which are subsequently found in the solidified metal.

In a substance like water, which expands on solidification, there are good grounds for the belief that the range from the maximum density at 4 deg. Cent. down to the freezing-point at 0 deg. Cent. covers a period during which active molecular aggregation is occurring. Observations on bismuth and its alloys may show that a similar state of things is to be found in metals, and, in any case, it is much to be desired that we should have refined and accurate density determinations of liquid metals in the neighborhood of the solidifying point. The fact that the majority of metals contract on solidification, and, therefore, do not show the phenomenon of a point of maximum density some degrees above the solidifying point, need not blind us to the importance of these density determinations. It is probable also that the measurement of changes of electrical conductivity with temperature in the liquid metals would be a valuable aid in this inquiry.

In conclusion, it appears to the author that while it may not be possible to establish Quincke's view, that in all cases solidification is preceded by segregation and the development of a "foam-cell" structure, yet that among recorded observations there are some which give color to the view that, at any rate in alloys and impure metals, there is segregation under the influence of surface tension in the liquid or the partially solidified state.

The more general inquiry as to the changes which precede solidification in metals appears to be a promising territory which is awaiting exploration, and it is to be hoped that the preliminary inquiry which is about to be made into the work which has been done in the various pioneer camps which have approached this territory from various sides will lead to the establishment of new camps within the territory itself.

The Penetrating Radiation

By Prof. W. W. Strong, University of Pittsburgh

The penetrating radiation is one that has been found to be universally present over all land surfaces and is very similar in nature to very hard X-rays or the V-rays of radium. It was discovered simultaneously in 1902 by Rutherford and Cooke working at McGill University, and McClennon and Burton working at Toronto University. The former observers predicted its existence, arguing that the presence of radium products in the ground and in the air should be the source of a penetrating V radiation. These observers found that the penetrating radiation ionizes the gas in a closed vessel or electroscope. By placing a lead screen 5 centimeters thick or a water screen 70 centimeters thick around the electroscope, it was found that the ionization was decreased about 30 per cent in quantity. A further thickening of the absorbing screen did not reduce the ionization, and the conclusion was therefore reached that a screen of lead about 5 centimeters thick is necessary to absorb the penetrating radiation. The ionization of a gas in an ordinary vessel is due to this penetrating radiation and to a "natural" ionization of the gas, part of which probably comes from the walls of the vessel.

DAILY AND ANNUAL VARIATIONS.

Further investigations upon the penetrating radiation have shown that its intensity is not constant but shows daily and seasonal variations. This was first shown indirectly by Campbell and Wood, who discovered that the intensity of the ionization in closed vessels had maximum values at 11 P. M. and 8 A. M., and minimum values at 2 P. M. and 4:30 A. M. Strong found maxima at 10 P. M. and 9 A. M., and minima at 6 P. M. and 7 A. M. McKeon found maxima at 10:30 P. M. and 11 A. M., and minima at 6 P. M. and 5 A. M. Strong considered that this variation of the ionization in closed vessels was due to a variation of the intensity of the penetrating radiation, the "natural" ionization of the vessel remaining constant. This theory does not require that the percentage change in the ionization should vary directly as the intensity of the penetrating radiation. The penetrating radiation probably generates a secondary radiation from the inside surface of the closed vessel. No very definite knowledge has been obtained of the seasonal variations although Mache has found a maximum in the autumn.

VARIATIONS CHARACTERISTIC OF THE LOCALITY.

The rocks and various soils of the earth do not contain the same amount of radium. For this and other reasons the amount of the gaseous radium emanation in the air which has diffused from the various surface soils is different for different places. The penetrating radiation therefore varies in intensity at different places. For instance, Gockel has found values approximately as follows: in a garden 6.4; in a room 9; in a tunnel of granite 30; in an ice chamber 0. In general it has been found that the intensity of the penetrating radiation is very weak over water surfaces, lakes and oceans. This is usually explained as due to the poverty of ocean water and air in the radioactive products of radium and thorium. Pocim has observed that the penetrating radiation has a diurnal period over the water within a mile or so of land. This observation could be explained on the hypothesis that in this case the penetrating radiation came almost entirely from radium products in the air.

It might be expected that by placing screens on different sides of the closed vessel used for the measurements some idea might be gained as to the direction of the penetrating radiation. Such experiments have met with little success, and this may be partly due to the penetrating radiation being diffuse, much like the light one has on a cloudy day.

THE INTENSITY OF THE PENETRATING RADIATION AT DIFFERENT ALTITUDES ABOVE THE GROUND.

Some very interesting observations have been made upon the intensity of the penetrating radiation above the ground. If the source is the ground, we should expect that as we ascend above the ground the intensity of the penetrating radiation should decrease, on account of its being absorbed by the air. Experiments by Wulf on the Eiffel tower and Gockel and Hess on balloons indicate that at an altitude of 2,000 meters or more the intensity of the penetrating radiation may be only slightly reduced.

SOURCE OF THE PENETRATING RADIATION.

While the general theory cannot be considered as being definitely proven, yet it seems probable that the penetrating radiation is due to the Y-rays from radium, thorium and uranium products in the ground and from radium products in the air. The rays from the ground are probably fairly constant at any one place but vary in different localities. The rays from radium products in the air probably vary in intensity during the day and depend to a large extent upon weather conditions. The relative intensity of these two radiations probably varies greatly at different places and at different times. In Toronto it seems that the radiation from the ground constitutes a large portion of the penetrating radiation. At some other places it is probable that the radiation from the air forms a considerable fraction of the total penetrating radiation.

The Production of Indelible Inks for Glass and Metal may be effected according to the following recipes in *Pharmaceutische Zeitung:* Black: soda, water-glass 1 to 2 parts, fluid India ink 1 part. White: soda, water-glass 3 to 4 parts, Chinese white or permanent white (sulphate of baryta) 1 part. The bottles containing these inks must be closed air-tight, and, before use, well shaken. Steel pens are used for writing. After use the pens must be thoroughly cleansed. The writing is not affected by any reagent used in microscopy, but can easily be erased with the penknife. For writing on glass a mixture of shellac solution and washed chalk has proved very satisfactory (coating with varnish is unnecessary). As the chalk may previously be mixed with any desired color, colored glass inks may in this manner be produced. If the glass has been perfectly cleansed, by means of alcohol or ether, writing can be accomplished very nicely with such glass inks by means of a pen or brush

Sunshine and Shadow*

A Problem in Architecture

By J. R. Hoffert, C.E., Ass't Eng. Penn. Health Dep't., Bureau of Design and Construction

The problem here presented is one which will probably seldom arise in the practice of a civil engineer, yet it is one which a recent "grad" was called upon to solve. The solution, while somewhat simple, may be adapted to various problems and moreover a little study of the paths apparently traced by the sun will go a long way toward fixing in the mind some valuable facts concerning that luminary. It is for these reasons that the solution is here presented.

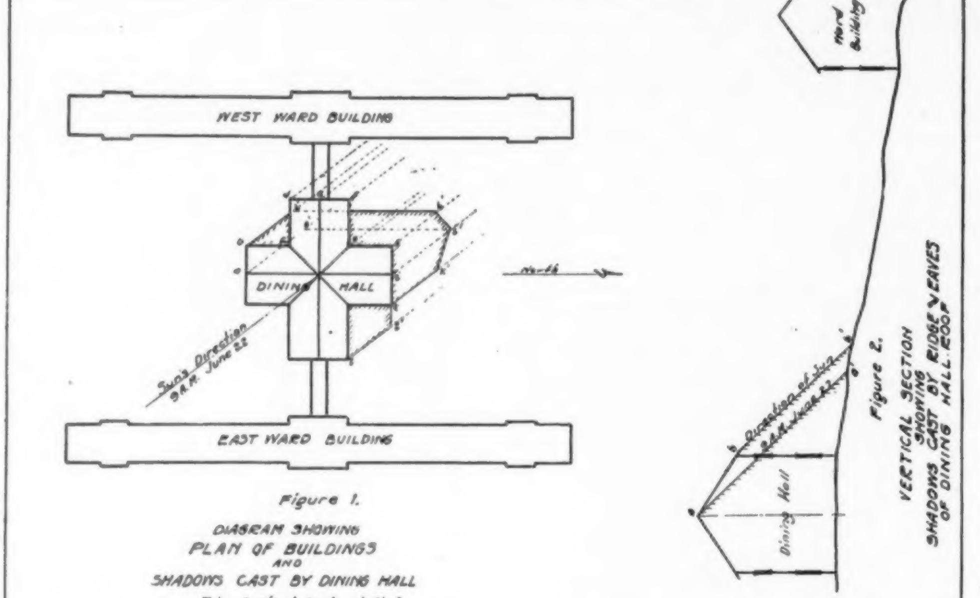


Figure 1.
DIAGRAM SHOWING PLAN OF BUILDINGS AND SHADOWS CAST BY DINING HALL
This Scale = ½ Scale of Fig. 2

Figure 2.
VERTICAL SECTION SHOWING SHADOWS CAST BY RIDGE & EAVES OF DINING HALL ROOF

The problem in question arose in this manner. Plans were being made by the State Health Department of one of our Eastern States for establishing another state sanatorium for tuberculosis patients. Such an institution, of course, includes many buildings, such as rows of four-room cottages and sun pavilions; ward and dining buildings; heating and laundry plants; baths, etc., in short, everything required for a large community of patients isolated on a remote mountain side.

One of the most important factors governing the "layout" of the buildings is the amount of sunlight which will be received in the various rooms of the buildings.

The more healthy patients are housed in square four-room cottages of a most improved type. These cottages are arranged in double rows, the spacing between cottages being such, and the cottages in the two rows being so "staggered," as to avoid any shadows on any cottage. Since such a type of cottage will receive the maximum total amount of sunlight in a year, by having a diagonal running due north and south, the rows of cottages are laid out due north and south and the buildings so placed that one diagonal is parallel to this line.

Of equal importance is the location of the ward buildings where the patients in the more advanced stages are housed. These buildings likewise have their axes running due north and south. In the proposed institution the two ward buildings and the dining hall are connected by covered corridors to form a group of three buildings of the plan shown in Fig. 1. As planned, those buildings will lie upon a gentle slope.

When the architect's drawings for this group were presented, the Commissioner of Health expressed the fear that the length of the connecting corridors was not sufficient to prevent the higher dining hall casting an objectionable shadow on the ward buildings. This being an important matter, it was decided to make an investigation of this point, and the writer was assigned to the task.

He was given a table of the azimuths and altitudes of the sun, for each hour from sunrise to sunset, for the longest and shortest days of the year, and for the equinoctials. He was told that these values had been obtained *graphically* by another engineer and he was asked to check them first and then to make the shadow determinations.

After some little thought the writer devised the following graphical solution of the problem which was found to be both accurate and satisfactory. It was felt that the above three days were the controlling ones and hence the shadow investigations were limited to them. The method of course applies equally well to any day.

SUN'S AZIMUTH AND ALTITUDE.

To determine these quantities, two large circles of equal diameter were drawn as shown in the accompanying plate. The larger circle in Fig. 3 represents *now* the plane of the *equator*, and is accordingly divided into twenty-four equal parts ($a_1 \ldots . y_1$) corresponding to the hours of the day.

The circle in Fig. 4 represents a north and south meridianal plane. The equator is inclined at an angle Φ (the latitude of the place) to the plane of the horizon H H, as shown. Viewed from the standpoint of descriptive geometry, the line E-W corresponds to the "ground line," the line N-S is the trace of the profile plane; and the circle in Fig. 4 is the profile plane. Point O_1 represents now the horizontal projection of the north pole, while O' represents the center of the celestial sphere.

Now let us trace the apparent movements of the sun on the longest day of the year, June 22nd. On this date the sun has its maximum declination of + 23 deg. 27 min. Accordingly the line S-O', the apparent direction of the sun, is drawn on the northern side of the equator and making with it an angle of 23 deg. 27 min. Evidently a line drawn through point g' and parallel to the equator will represent the trace of the sun's apparent path around the earth on this day. It will now be necessary to locate the sun's position along this path for each hour. To do this the smaller circle is drawn in Fig. 3 with a diameter equal to the line t' g' and is then divided into twenty-four equal parts ($a_1 \ldots . y_1$), as shown. In Fig. 4, g' and t' correspond to g_1 and t_1 in Fig. 3, respectively, noon and midnight, while m' corresponds to m_1 and a' to a_1, respectively, 6 A. M. and 6 P. M. An intermediate point, as say the eight-hour point k', is located by measuring from m' toward g' a distance equal to the distance k_1 k_{11} in Fig. 3, and similarly for the others. Now project these points downward upon the plane of the horizon H H in Fig. 4, in points g'', h'', i'', etc. Consider *now* the circle in Fig. 3 to represent the plane of the *horizon* and on the lines g_1 g_{11}, h_1 h_{11}, etc., locate the horizontal projections of points g', h', etc., by measuring out from the line E-W, the distances O' g'', O' h'', etc., locating thus, the points g_{111}, h_{111}, etc.

Point O_1 represents now the position of the observer and hence lines drawn through O_1 and any of the above points such as k_{111} will represent the azimuth of the sun which can be scaled off with a protractor. In order to locate intermediate times and to determine the time of sunrise and sunset, a smooth curve is drawn through the points $a_{111} \ldots . y_{111}$. This curve (an ellipse) represents the horizontal trace of the sun's apparent path around the earth.

The point Z in which the line g' t' cuts the horizon is evidently the time of sunrise and sunset. Hence, a line drawn in Fig. 3 parallel to E-W and at a distance from it equal to distance O' Z will cut the curve of the sun's path in the points of sunrise and sunset, as shown in Fig. 3.

To determine the values of the sun's altitude it is only necessary to project the points k', n', p', etc., horizontally across to the circumference, draw a radius, such as $O'j'''$ for instance and measure the angle H-$O'j'''$.

The values of azimuth and altitude for the other days are obtained in a similar manner. For the equinoctial days of course the sun's path coincides with the equator, while for the shortest day of the year it is as much below the equator as it was above it on the longest day. In order to avoid confusion in Fig. 3, the construction lines are shown on the left for March 21st only and on the right for June 22nd only.

And now just a word about the notation used. The reader will perhaps be assisted in finding the various points of the diagram by noting that all vertical projections of the several points will be found in Fig. 4, and are indicated by primed letters, thus: a'; while all horizontal projections occur in Fig. 3, and are indicated by letters with a subscript, thus: a_1. The figures have, in the main, been lettered for the sun's path on

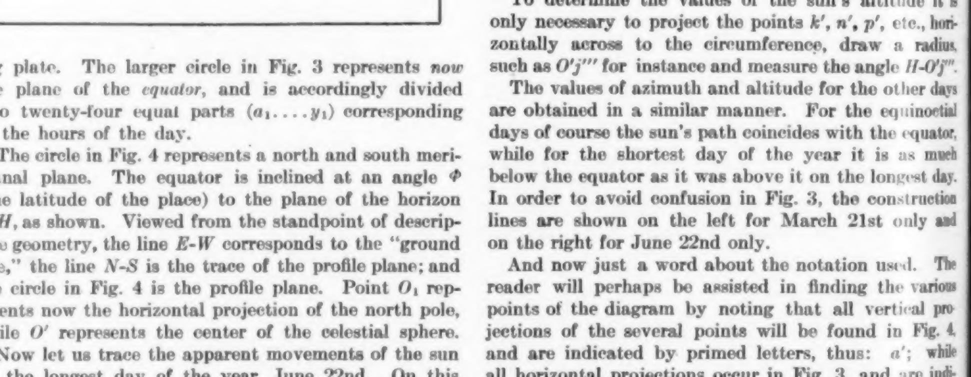


Figure 3 Figure 4

DIAGRAM FOR FINDING GRAPHICALLY THE SUN'S ALTITUDE & AZIMUTH

Factors Neglected
Hourly change in Declination
Refraction
Equation of Time

* Reproduced from *The Cornell Civil Engineer.*

June 22nd. However, in a few places, to avoid crowding, the points lettered are those corresponding to one of the other days. Thus, in the left half of Fig. 3, the points on the horizontal trace of the sun's path, and the hour divisions of the circumference are for the equinoctials. The positions of the corresponding points for each day will be readily apparent.

A little study of the various positions of the sun's apparent path will show how, beginning in December, when the sun rises only a short distance above the horizon and remains visible for but a short day, it gradually mounts higher and higher until on March 21st it remains above the horizon for exactly half a day, thus giving us a day and night of equal length. Then, mounting still higher, it reaches its maximum height above the horizon, giving us our longest day and shortest night on June 22nd. After this it begins its descent, similar in every respect to its rise. Thus, we again have an equinox on September 21st, and finally reach again the shortest day on December 22nd.

Another feature sometimes overlooked, is the fact that the sun traverses the *southern* portion of the heavens in our northern hemisphere. Again, it will be apparent that sunrise and sunset are equidistant (practically so) from apparent noon. A moment's reflection will also show why a watch will serve as a compass. Were a watch dial graduated into twenty-four equal parts (corresponding to the hours) it would merely be necessary to point the hour hand to the sun. In such a case the face of the watch would then be similar to Fig. 3, and twelve o'clock would point due south (barring the equation of time). Since, however, the watch is only divided into twelve hour spaces, to use it as a compass, we simply point the hour hand toward the sun and then know that due south lies *halfway* between the hour hand and twelve o'clock.

So much for a few of the things to be learned from Figs. 3 and 4.

DETERMINATION OF SHADOWS.

Having tabulated the values of the sun's altitude and azimuth for each hour from sunrise to sunset, for each of the three days, we are ready to attack the problem proper, i. e., to determine the shadows cast by the buildings.

In the present case 9 A. M. was chosen as a time at which the sun's heat and light were too valuable to be lost, and the shadows determined for this hour. The method, which is simple, is as follows: We will consider the shadow cast by the dining hall at 9 A. M. on June 22nd.

Through the point *a* (the ridge of the dining hall) in Fig. 1 a line is drawn making with the north and south line the sun's azimuth at 9 A. M. on June 22nd. In Fig. 2 the section of the dining hall, along this ray of light, is drawn and through the point *a* of its ridge a line is drawn, making with the horizontal, an angle equal to the sun's elevation at 9 A. M. Evidently this line represents a ray of light and the point where it cuts the ground surface will mark the limit of the shadow cast by point *a* of the dining hall. This distance is scaled off and laid off at *a'* on the ray of light along line *a a'*. Similarly lines parallel to *a a'* are drawn through every point of the dining hall that can cast a shadow. Points similar to *a'* are found in a similar manner and the outline of the shadow drawn in as shown. Of course, if the shadow overlaps the horizontal projection of the ward building it shows that this building is partly in shadow. To find the height of the shadow on any portion of the building it would merely be necessary to turn to the section, Fig. 2, and note the point at which the ray of light cuts the building.

In the matter of determining the shadows also there are several points of interest. Some labor can be saved and the plotting checked by noting that lines parallel to each other in the building will cast parallel shadow lines. Thus, were it not desired to use the point as a check, the line *b' h'* could have been drawn by plotting only the point *b'* and then drawing through it a line parallel to *b h*. Numerous other "short cuts" and "checks" will be apparent upon a little study. Of course, if the ground upon which the buildings were built were *very* irregular it would be necessary to plot each point to determine the true shadow. However, this would not affect the shadow on the buildings themselves.

As the sun's elevation decreases, the ridge of the roof will begin to cast its own shadow and there will be several independent shadows. Such was the problem and its solution. As a final commentary it may be of interest to note that it was decided to increase the length of the corridors. After all the investigation was of some good.

Safety First—II*

Accident Prevention on Railroads

By Ralph C. Richards

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 1921, Page 272, October 26, 1912

WHEN we commence to exercise the same care in the selection of new men and in educating them as to their duties that we do in the selection and care of new machinery, cars and engines—and somehow it has always seemed to me that men were the important element on a railroad, or in any business, not the machine—we will have safer and more regular operation and fewer accidents. It seems to me that during the last ten or fifteen years the railroads have been devoting all their energies to getting good things instead of good men; I don't say that we haven't good men, but that more time has been devoted to getting good things than to getting good men. I believe, that our system of hiring men is obsolete. We really haven't any system, and we must have one. We have been devoting all this time to getting fine engines, fine tracks, better cars, better apparatus and better safety things, but very little time or attention has been paid to getting safety men, and if we had devoted as much time and thought to getting safety men as we have to getting safety things, and educating the men after we got them, our accident record would be different. And we ought to have instructors of rules and regulations the same as we have instructors of air brakes. Such a man could do an immense amount of good in the way of educating the men and preventing accidents.

Men are of so much more importance than things. There is no comparison between a man and an engine. If an engine is smashed or demolished, we can buy a new one. If a man is smashed or killed, we cannot bring him back to life, and it takes years, not weeks or months, to make a good railroad man. Should we not, then have some thought, some plan for the conservation of men? Take for example a railroad. It may be a poor railroad with poor tracks, poor cars and poor engines, but if it has good men we all know we can get good results, and we can handle the traffic, and gradually the good men will build up the poor railroad and make it a good one; but take the best railroad in the world, with the best cars, the best engines and the best tracks, if it has a poor lot of men to run it, in a year or two it will have gone to pieces. I believe, therefore, that it is men, not things, that are important on a railroad, just as they are of the most importance everywhere. And when the man who inspects is not charged with the duty of repairing the defects he discovers, when every accident is investigated immediately by some competent, disinterested person for the purpose of ascertaining the cause and applying a remedy, and not to cover it up, we will bring about much better results.

The Pennsylvania System, the Delaware, Lackawanna & Western, the Elgin, Joliet & Eastern, the Baltimore & Ohio, the Frisco system, the New York Central Lines, the Illinois Central, the Burlington and some other roads have adopted the same safety organization as the Northwestern, or one very similar, and many other roads are now considering the matter. What it will mean to the working men of this country, their families and dependents, to the industries employing them and to the public generally if, by concerted and enthusiastic effort and co-operation, we could bring about a reduction of 25 to 50 per cent in the fatalities and injuries, must be obvious to everyone. I am satisfied, from the little experience that I have had, that it can be done.

Emerson says, "Every great and commanding movement in the annals of the world is a triumph of enthusiasm." Whether a movement tending toward safety in industrial operation, or, in other words, a movement for the conservation of men, is a great and commanding movement, depends, perhaps, upon the point of view from which the subject is considered; but if, as to most of us, life is the most precious of our possessions, any movement for the preservation of life ought to be a great and commanding one, and should be enthusiastically supported by every working man as well as by every employer, and with such support it must necessarily be successful.

I have told you what the work of our safety committees has done for the men. I shall now try to state as briefly as possible what I think it has done for the Company. Most important of all it has, I think, created a greater spirit of co-operation and good feeling between the rank and file and the officers of the Company than has existed for years because their monthly meetings have made an opportunity for them to get acquainted, and as that acquaintance grows, as it must by continued association, that feeling of good-will and mutual interest and co-operation must necessarily increase. The following letter from W. A. Gardner, president of our company, will tell you what he thinks about the safety movement:

"There is always a variety of anxieties and responsibilities connected with railway operation, but nothing is so exhausting to one's vitality, or keeps your nerves strung up to the highest pitch, as do the injuries to employees and others. It seems that we could reconcile ourselves to almost every other trouble if the list of killed and injured could be eliminated. Our records for the past months indicate an extraordinary decrease in accidents, and owing to the energy of the safety committees and their individual zeal and hard work, the Northwestern company is in fair way to realize something that we have only been able to speculate or dream about for a number of years. On behalf of the board of directors, permit me to express to the committee and yourself the company's sincere appreciation of your efforts. With patience and persistency I believe that we will eventually eliminate the cause of a very large percentage of our distressful accidents and, like a great many other things, if we anticipate irregularities, there are no ill effects to follow."

It has provided a method of presenting to the officers of the company the suggestions and ideas of the men and what the men think as to how the work could be made safer and the operation of the road more efficient, and regular in an orderly and respectful manner without the intervention or assistance of grievance committees, and it has also made a place where the officers could explain to the men why their suggestions and recommendations could and should not be adopted, when they are not proper or practicable. We all know that, when a man has had a chance to speak his piece and present his ideas and has had it explained to him why he is wrong, he is generally satisfied, as he never would have been, if he had not had the opportunity, and if you gentlemen could have heard some of the discussions in these committee meetings, generally between the men, frequently between those employed in different departments, where both sides of the question were threshed out, you would understand what this means and some of you would, I think, have learned something about conditions surrounding the difficulties of safe and regular operation and how they could be improved, as I have and as I am sure other general and division officers of our road who have listened to them did learn. So far as I know, not until the organization of these safety committees, was there any place at which such matters could be brought up and threshed out.

It has, I believe, largely increased the efficiency of the organization by keeping the old experienced men at work who previously were only too often taken out of the service by reason of accidents, and, avoided the introduction of so many new and inexperienced men in the work. How much easier and with how much more regularity, promptness and safety the trains on a railroad can be run when it has in seventeen months twenty-six fewer trainmen killed and 2,012 fewer trainmen injured than it had during the preceding seventeen months, you operating men know better than I do.

As the men acquire the safety habit and become more careful of themselves, their fellow employees, passengers and others, it seem to me that they must necessarily become more careful not only of the property of the company, but also of the property intrusted to the company for transportation and consequently operation must necessarily be not only more efficient, but more economical.

You all know how much time division officers have been obliged to give to the investigation of accidents, the taking of statements, making reports and explanations and the trouble and friction that has been caused by the necessity of disciplining men, so I think it must be apparent that if you can reduce your accidents

*Extracts from an address at the annual meeting of the General Managers' Association of the Southeast, at Atlanta, Ga., June 13th, 1912.

one half—and it can be done—the time heretofore taken in making such investigations and reports can be devoted to the proper supervision of the work of operation and maintenance, and consequently much better and more economical results obtained.

I stated in the early part of this address, what the percentage of increase of accidents on our road was for the year ending June 30th, 1910, over 1909. I give you below the figures and tables for those years and the percentage of decrease for the last seventeen months as compared with the seventeen months before the safety work was organized, as well as the figures showing the number of injuries we would have had if the same percentage of increase had continued during the last seventeen months that we had in 1910 over 1909:

	12 Mos. ending 6-30-'10		12 Mos. ending 6-30-'09		Increase.		Percentage of Increase.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Employees	107	8629	78	6788	29	1841	37%	27%
Passengers	11	928	8	674	3	254	38%	38%
Others	235	606	198	542	37	64	19%	12%
Total	353	10,163	284	8004	69	2159	24%	26%

	17 Months, ending 12-31-'10.		Percentage of Increase added.		17 Months, ending 5-31-'12	
	Killed.	Injured.	Killed.	Injured.	Killed	Injured.
Employees	149	12,221	204	15,520	106	8215
Passengers	21	1197	29	1651	13	993
Others	317	856	377	958	244	724
Total	487	14,274	610	18,129	363	9932

And, I believe, in view of the fact, that there has been no decrease in the operating expenses during that period it would be fair to presume that the accidents would have kept up at the same old ratio, the same as the expenses have kept up. No one pretends that all of the decrease in the number of accidents has been brought about by the safety committees, but in view of the fact, that we have not increased or changed our signals, safety appliances, or rules, that our earnings have decreased only 6 per cent, and that we have not made any material changes or improvements in our methods, other than those suggested by the safety committees, it is, I think, fair to presume that the larger part of the reduction shown can be credited to that organization; and as during the last seventeen months, we have had 4,466 fewer personal injuries you can readily figure out from the average cost of such cases on your own lines what it means in dollars and cents. On our road, where that average cost is, I think, no higher than that of our neighbors in the same territory, it will amount to about $576,738.90, which certainly is worth saving and which will help keep up the equipment, track, bridges and buildings, as well as take care of some of the increase in operating expenses which every railroad has had in the last two years.

Before I close I want to say a few words about accidents in which trespassers are killed and injured. During the last ten years 50,025 trespassers have been killed (one half of all the people killed on the railroads) and 53,427 injured on the railroads of this country—14 killed and 14 injured every twenty-four hours—as against 4,435 killed and 1,319 injured on the railroads of Great Britain, or a little over one killed each day and one injured every third day, yet we do nothing to put a stop to trespassing either in the way of enacting proper trespass laws or in enforcing them in the few places where we have them. Yet, as a matter of dollars and cents it would cost the States and municipalities less to enforce a proper trespass law, than it does to hold inquests bury the dead and support the cripples without taking into consideration the important item, the waste of human life and the making of cripples. And, by far the larger part of those killed and injured come from the respectable walks of life; they are not tramps, as the public seems to believe. I should think, from our own reports and from the statements made in the article written by Frank V. Whiting, the general claims attorney of the New York Central Lines, that less than 25 per cent of the trespassers killed and injured on the railroads of this country are tramps and if my estimate is correct, between eighteen and twenty thousand of those killed and injured, are young men and women under 21 years of age, and probably one half of those are less than 14 years old. And when you come to think, that every ten years, we kill and injure enough young people trespassing on the tracks of our railroads to make a mile post for nearly every mile of travel in a trip around the world, we can realize what a great evil this trespassing is and how necessary it is that something should be done immediately to put a stop to it. And, yet children are allowed to play and walk on the tracks, jump on and off moving cars, and if the railroad people report or complain of them to the parents or to the authorities, not only is nothing done to keep the youngsters away from the railroad, but generally the parties complained to resent the making of the complaint. Nearly every town has one or more children going around minus an arm or leg, that has been lost in an accident, caused by trespassing on a railroad, or there is some little grave in the village cemetery made from the same cause. Some day, public opinion will awaken to this fearful loss of human life and then laws will be made, and I hope enforced, and that will put a stop to the trespass crime.

Trade Notes and Formulæ

Copper Mixture.—Sulphate of copper 5 parts, soft soap 10 parts, water 1,000 parts. The sulphate of copper is dissolved in about 100 parts of water and to this solution, stirring constantly the while, is added the previously prepared soap solution.

For the Preservation of Rubber Goods.—Thal, in *Pharmazeutische Post*, recommends sheet-tin boxes, in which are placed shallow glass saucers containing solid carbonate of ammonia. By observations extending over a period of fifteen years, Thal has established that in such boxes, the rubber goods are not liable to deteriorate.

Grapevine Spraying Fluids (Bordeaux mixture).—16 parts burned fat lime are slaked and thinned with water to 500 parts. The resultant, milk of lime, is poured off from the coarse impurities and mixed with a solution of 30 parts of blue vitriol in 400 parts of water. After vigorous stirring the whole is made up to 1,000 parts. It is very advantageous if to each 1,000 parts of mixture 30 parts of sugar are added. By this means, according to *Drogisten Rundschau*, burned spots on the tender young leaves, due to the spraying, are avoided and the mixture adheres better to the leaves.

Artificial Sponges.—These may be produced from pure cellulose, which has been mixed with coarse rock-salt and exposed to the action of chloride of zinc. This mixture is pressed in a machine provided with points which in passing through the mass perforate it with small channels closely resembling natural sponge. The mass is subsequently steeped in a weak solution of alcohol to extract the surplus salt. The sponge thus made hardens when dry, swells up in water, just like a natural sponge. It can be used for the rough filtration of water and in a general way for the same purposes as natural sponge.—*La Nature.*

Bengal Papers are made, according to *Drogisten Rundschau*, by immersing unsized paper in a watery solution of the proper metallic salts. Red flame is obtained by solution of 2 parts nitrate of strontium and 1 part chlorate of potash in 2 parts alcohol and 10 parts water; green flame by dissolving 2 parts of chlorate of varium in 2 parts of alcohol and 10 parts of water; yellow flame by dissolving 1 part each of chlorate of potash and oxalate of strontium in 2 parts of alcohol and 10 parts of water; blue flame by dissolving 2 parts of copper and 1 part of chlorate of potash in 2 parts of alcohol and 10 parts of water; violet flame by dissolving 15 parts each of strontium, chlorate of copper and chlorate of potash in 100 parts water and 50 parts alcohol; lilac flame by dissolving 2 parts chlorate of potash and 1 part each of chlorate of copper and chloride of strontium in 5 parts of alcohol and 10 parts of water.

Enamel Pencils for Writing and Drawing.—Dissolve 2 to 10 parts of gum dammar or shellac, 1 to 2 parts bichromate of potash, 50 to 100 parts of leaf-gold or pulverized gold-bronze, copper-bronze or other metallic bronze or color in 100 parts of paraffin and add 5 to 20 parts of naphthol. The last serves to prevent oxidation of the mass and bleaching out of the colors, and with the paraffin furnishes the binding material for the mass. For colored pencils the required quantity of color is added to the above mass. To procure a more rapid shading of the colors and produce a moiré-like stroke, from 1 to 10 parts of ground mica is added to the mixture. According to *Neueste Erfindungen und Erfahrungen* all the ingredients should be heated in a vessel and thoroughly mixed together by stirring; the mass obtained is then dried until it attains a certain consistency, and finally is pressed in molds.

To Remove Fusty Stains from Leather.—To remove fusty stains from leather it should be placed in an atmosphere of dilute ammonia. This is effected either by placing the leather in a stable, where the manure continuously gives off ammonia, or by hanging it over hartshorn salts, or similar ammonia-yielding substances, or by packing the material in sawdust which is impregnated, in a suitable manner, with such chemicals. When the fusty stains are removed in this manner, the leather can be dyed black by the usual process, using logwood—oak dye. It must be noted that in this case, before treatment with logwood, a bichromate mordant must under all circumstances be used. Moreover, says *Technische Rundschau*, care must be taken that a sufficient surplus of logwood is provided, so that all the iron may be fixed by it. If this is not the case, and there is an excess of iron in the leather, it will speedily be rendered brittle by oxidation.

Tin Writing Tablets.—In soda or potash waterglass of a specific gravity of 1.25, fine slate powder in a moistened condition is mixed and ground with some lamp-black, vegetable charcoal or bone coal. With this the tin sheets, which must of course be perfectly freed from grease, may be painted or spread as often as desired. Of course, this mass is non-elastic, and the tin sheets must not be subjected to bending. If bending cannot be avoided, coating several times with caoutchouc solution with a filler of bone coal, slate powder, pumice-stone powder, iron-black, graphite, and in addition sulphur, is recommended. The coating is then vulcanized. The addition of filler, coloring substance and sulphur, the temperature of vulcanization and the duration of heating, must be so ordered that the rubber coating acquires a hardness that is between that of ordinary elastic rubber goods and that of hard rubber. If too much filling is used the rubber coating will be too porous.—*Technische Rundschau.*

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